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Scientific Survey of Maine 18

SIXTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

MAINE BOARD OF AGRICULTURE;

EMBRACING ALSO THE

First

REPORTS ON THE SCIENTIFIC SURVEY.

Natural History and Geology (prelimin

1861. p. 146

p. 377

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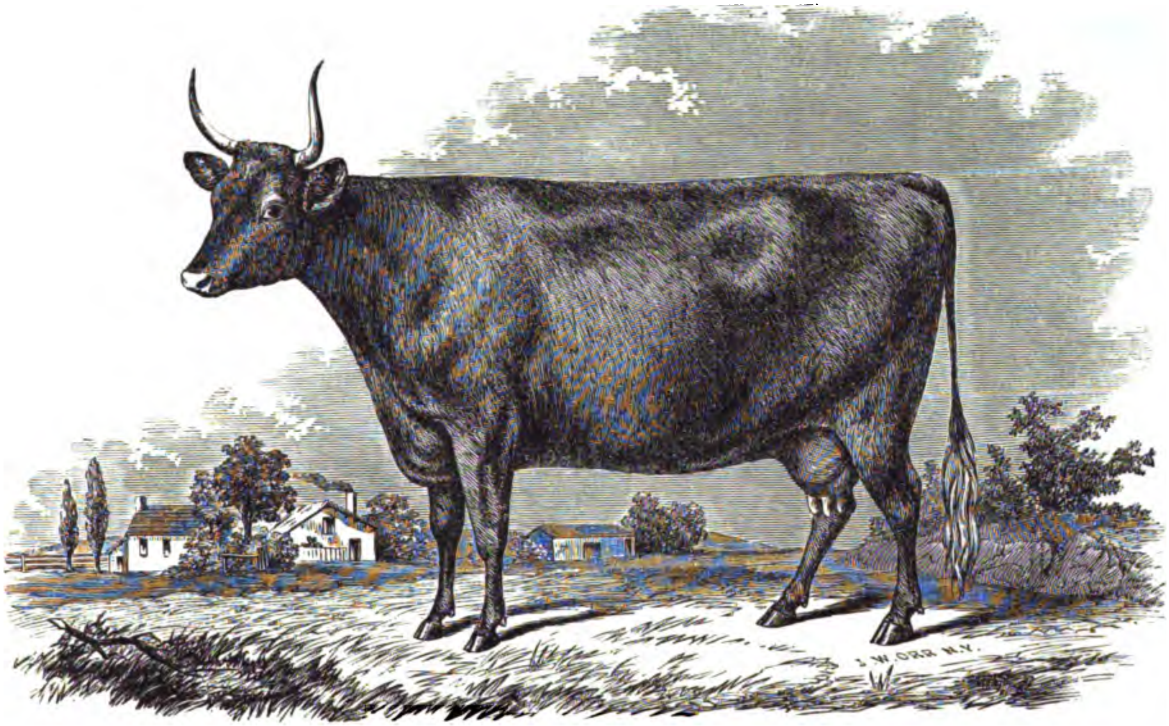

DEVON COW, BOWLEY. 42.

Imported by Edward G. Faile, West Farms, Westchester County, N. Y., from the herd of George Turner, Esq., of Barton, near Exeter, England. Gained first Prize at the American Institute Show, New York, 1859.

J C Branner

SIXTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

MAINE BOARD OF AGRICULTURE.

1861.

See page 13

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BOARD OF AGRICULTURE....1861.

SAMUEL F. PERLEY, *President.*
SAMUEL WASSON, *Vice President.*
STEPHEN L. GOODALE, *Secretary.*

NAME.	COUNTY.	P. O. ADDRESS.
Term expires January, 1862.		
E. L. Hammond,	Piscataquis,	Atkinson.
Hugh Porter,	Washington,	Pembroke.
J. S. Chandler,	Franklin,	New Sharon.
Joel Bean,	Aroostook,	Presque Isle.
J. C. Weston,	Penobscot,	Bangor.
Samuel Wasson,	Hancock,	Ellsworth.
Term expires January, 1863.		
John Currier,	Lincoln,	Waldoborough.
David Cargill,	Kennebec,	East Winthrop.
Robert Martin,	Androscoggin,	West Danville.
Calvin Chamberlain,	Maine State Society,	Foxcroft.
David Norton,	Waldo,	Montville.
Term expires January, 1864.		
S. F. Perley,	Cumberland,	Naples.
Geo. A. Rogers,	Sagadahoc,	Topsham.
Ellis Fish,	Somerset,	Hartland.
Farnum Jewett,	Oxford,	North Waterford.
S. L. Goodale,	York,	Saco.

REPORT.

To the Senate and House of Representatives:

The Board of Agriculture met at the Capitol in Augusta, January 16, 1861. Permanent organization was effected by the unanimous election of the following officers:

Samuel F. Perley, *President.*
Samuel Wasson, *Vice President.*
S. L. Goodale, *Secretary.*

Messrs. Wasson, Chamberlain and Goodale were appointed a Business Committee to present subjects for the consideration of the Board.

Mr. Chamberlain presented a report on a subject assigned him at the previous session, as follows:

What specific changes in the management of our agricultural societies would increase their usefulness?

REPORT.

This question is one that presents itself to the managers of all these associations, from that of a town, to that of the National Society, and recurs with each successive year's operations.

Change, merely for the sake of change or novelty, is not without its effects. This is well understood by all who aim to move the masses either for good or for evil. There is now a waning interest in agricultural exhibitions. The changes that have been rung, "to draw the crowd," have ceased to be potent. The people tire, and tell us by their absence, that "the thing does not pay."

The last exhibition of the United States Agricultural Society, from the small number of visitors, is reported as a failure. The reason assigned is, that local exhibitions—County and State—detracted from it. There was not a concentration of local interest.

Our own State Exhibition, though a reasonable success as a show, sufficiently full to interest and instruct any inquiring visitor, lacked in patronage. It failed to pay its current expenses.

The reports that have reached us, are almost unanimous in representing a great abatement in interest in sustaining county and state exhibitions. This could not arise from a lack of the usual pecuniary ability of the people to indulge in a holiday that could be turned to so good an account as that of visiting a well ordered, industrial exhibition.

This is a period in our affairs, when we may well nigh despair of seeing future good through organized effort, if our organization, as it now is, is as perfect as it can be made—founded upon the right basis, and fully up to the condition and wants of society.

It becomes us to consider fully and now, the vital question before us.

In committing this subject to one mind for treatment, the Board could not hope to see remedies promptly applied to what may be a complication of diseases, and when the patient had hitherto been treated on the Chinese custom—a multitude of doctors having been retained to keep the patient in health.

A diagnosis of the case will be attempted.

The bounty of the State is extended to agricultural societies, as payment for labor done and performed as per contract. Cash paid for statements, which, in advance, are presumed to be rich in desirable knowledge, adapted to general application—the result of careful experiment, wise forethought, or a systematic application of known truths, principles of natural laws, to produce desirable results.

Under this system we have now operated for a series of years. It is a success? Do the people of the State receive an equivalent for the money thus disbursed through their treasury? Enough has been written in the published agricultural reports, on this point, without enlarging upon it here. Has the nice, discriminating, moral sense of the people, taken alarm at the modern practice of showing the speed and bottom of the noble horse, or the encouragement given to the graceful and healthful exercise of ladies riding on horseback? The decrease in interest towards our exhibitions, has operated to increase the difficulty that the managers have ever encountered—that of securing the services of competent awarding committees. In this regard I will speak particularly of the State Society, for with that, I have of late been most familiar.

The trustees have, through the aid of members of the Board of Agriculture, the officers of the county societies and other reliable individuals, aimed to secure the best men in every portion of the State. A portion of those invited—perhaps less than one half—accept their assigned positions; and of these, many delay their attendance till the fair has so far progressed that their services have been superseded and the duty performed by others. The necessity of selecting men during the progress of a fair, puts men in position where they serve with reluctance, or it gives men place who are utterly incompetent, or it affords a knave an opportunity by concealing or denying the fact that he is an exhibitor, to do great injustice, bringing dishonor on the society, and lessening the value of the awards themselves, as indications of the real opinion of the society respecting the article exhibited.

I had the pleasure of making short visits to two county exhibitions in October last, and one of these occurred near the closing hour of the show. The regulations at both carefully excluded all indications of ownership from every article on exhibition. On one of these visits, in taking notes of what I saw, I wished to notice some individual exhibitions; but to obtain any knowledge of ownership cost me much time. Is this course the better one? You select for your judges, men and women, for their intelligence and integrity; you instruct them to exclude all persons who shall attempt to interfere in their adjudications. You then virtually say, we distrust you, and cannot expect honest decisions except where ownership is unknown, and consequently favoritism excluded. I acknowledge to having put a higher estimate on "poor human nature," in its better phases, than is indicated by this rule. Without looking deeper for what may be defects in present practice, I think we can find, outside of the working machinery of the societies, sufficient cause to account for all the apparent decline in our exhibitions. Agricultural exhibitions have amazingly multiplied of late.

The area of Maine is not so vast, nor intercommunication so formidable as to preclude any from joining in, and being benefited by a State Show. Yet some of our stock-growers seem not to be satisfied with a fair share in a common cause, but must have two state shows.

No county in the State has a surplus of element after providing for one show and making it what it should be. Yet we see an attempt to maintain three or four in a county. Town shows—good institutions in themselves—become ruinous to the cause at large, when the farmer or mechanic permits this neighborhood affair to pass for the annual holiday for himself and his family—saving a little in current expenses, and missing all the knowledge to be gleaned from an extensive collection, embracing varied pursuits and a multiplicity of products of industry, and presenting the latest improvements in all.

We will venture to suggest for consideration, that industrial shows, originated and conducted for the benefit of a town, or neighborhood of narrow area, should be considered auxiliary to, and directly promoting the interest of a more comprehensive organization. That if held but once in the season, it should be prior to that of the county or state show; that they should be conducted as market fairs, and as occasions for ascertaining the existence of articles, such as should be sent forward to the larger exhibitions, and to make the arrangements for sending them. That where more than one society exists in a county, they be consolidated and located permanently. That the bounty of the State be set apart by each county society, and offered in prospective premiums on general farm improvements, on the plan of the noble example set us by the county of Cumberland; and for the encouragement of exact experiments in the manufacture and application of manure, and the rearing and fattening of domestic animals. That the state society locate its shows for a series of years either permanently at one point, or alternating at two or three. That the usual number of awarding committees be reduced, and that the several chairman of committees be chosen at the annual meeting of the society, and that they be paid a reasonable compensation for their services.

We will present, briefly, some of the advantages to be derived from a permanent location.

Hitherto the society has incurred heavy annual expenses in putting up and pulling down fixtures; and the arrangements have, in each instance, been incomplete, in that such part of the exhibition as required protection from the weather, has been located in such places as could be obtained in the vicinity of the show ground—in each case within the distance of a few miles—subjecting the officers of the society to much travel and loss of time to superintend its operations; requiring a large number of attendants and police;

causing visitors much annoyance and expense in keeping their accounts for admission tickets on the system of "double entry;" and operating to thoroughly disgust a large portion of the visitors and contributors, and effectually preparing them to be content with a home-made, neighborhood show, next year.

The expense incurred in erecting and removing fixtures, is a loss to the State as real as that amount destroyed by fire. Adopt a course to save this large annual loss, and in a few years it would be sufficient to pay for the erection and maintenance of the proper structures for the accommodation of all the desired display of the varied products of the State.

Make the accommodations ample and easy of access, commodious fixtures, and our shows would at once assume a character that can never be attained under the itinerant system with the best of management, and with all the pecuniary aid that any locality can be expected to extend to it. Let it be well housed and provided, and it may be understood that a "line storm" cannot "wilt" it; but on the return of sunshine, the people may find it in perfect health and in working order. With a permanent location, attractions could be created which would make the state fairs self-sustaining, independent of the state treasury, and give a fund with which to extend premiums on a scale more liberal and diversified than heretofore.

The operations of useful and complicated machinery, will ever attract a crowd of the curious and the interested; and it must be so while American genius and character maintains a semblance of its present type. The encouragement extended to that intelligent class of citizens, who devise and manufacture machines and implements—those potent aids to human toil in the varied pursuits of life, has not been commensurate with the importance of their productions. Our implements are next in importance to the power that guides them.

With a permanent location, a moderate outlay would provide the motive power for operating machinery, and furnish the facilities for entering upon and conducting understandingly, a trial of all field implements, thus enabling judges to make their reports and awards so as to confer very great benefits on the farmer and mechanic, whose interests are so closely connected and so mutually dependent.

A considerable item of expense in a protracted cattle exhibition, is in the article of forage. An area sufficiently spacious to accommodate the show, ought to produce all the hay and corn fodder required, reducing a very large sum to the simple expense of securing the crop at home; and this arrangement would afford opportunity to test implements for culture and harvesting.

The experience of the most efficient agricultural societies in the United States, points unanimously to the advantages of a permanent location.

The society operating on the most gigantic scale, is located at St. Louis. Indiana is doing a great work with hers, located at the capital. Michigan would have located at Detroit before this, but for the hope of future accommodations on their state farm, at the new capital. New York and Ohio, from their extent, and their great number of cities and large towns, affording accommodations for a multitude, are better situated than most other States for the useful continuance of the migratory system; yet they have long since seen and acknowledged the many advantages to be derived from a permanent location; and in Ohio, an effort to locate was once nearly successful. Connecticut is moving in the same direction.

The counties of Cumberland, Kennebec and Penobscot, by locating their Fairs, severally, at or near Portland, Augusta and Bangor, would be in position to act efficiently of themselves; and by joining action with the state society, might, in a few years, be in possession of all the desired accommodations for the largest exhibitions at these several important points."

The report was accepted, and gave rise to an animated discussion, protracted, at intervals, throughout several days. The subject was one of great importance, and required thoughtful and careful deliberation. It was suggested that the 'waning interest' in agricultural exhibitions the past year, might be owing in large measure, to the fact that there were so many other gatherings of people, especially for political purposes, that they began to be tiresome, rather than from any lack of interest in agriculture.

Mr. Cargill said that many valuable suggestions were developed in the report. There were without doubt numerous faults in our system of agricultural societies, and a prominent one is their multiplicity. We should merge them together. Instead of several weak ones, we should endeavor to have one strong society in each county.

Mr. Jewett of Oxford, suggested as means of remedying some of the evils attendant upon society exhibitions, a reduction of the number of awarding committees, and greater care on the part of trustees to obtain competent men, and paying a reasonable amount for their services to secure their attendance.

Considerable difference of opinion was expressed regarding the policy of having the names of exhibitors attached to their articles.

Mr. Cargill said it had been the custom in the society with which he was connected to suppress the names of exhibitors. But with all the care they could take, the names *would* leak out. Sometimes certain members of committees are so strenuous in their adhesion to pre-conceived opinions that their associates have good reason to believe they may be cognizant of the ownership of the articles under examination. He would take away the distrust under which the committees are now placed by making the names of exhibitors known to all. He was at any rate willing to try the experiment.

Mr. Bean was not disposed to distrust committees, but all men are selfish. Having seen the working of the present system, he was of opinion that leaving the names open to the inspection of the committee, would not accomplish any good, but rather harm. There is already much complaint that such a *man* takes the premium, not the article exhibited. If the names could be entirely withholden from the committees, there could be no ground for complaint. Everything would be done fairly, without favoritism.

Mr. Hammond said that it added much to the interest of the show to see the names of the exhibitors. This was the only practical effect of the resolution. All know how common it is for committees to receive hints as to the ownership of the articles. He thought the names could not be suppressed and the best way was to have the thing entirely open. He thought it a good idea to suggest this to the societies so that the matter might be brought before them, and they would have an opportunity to settle the matter for themselves. Any action the Board might take would be advisory and not compulsory upon the societies.

The result of the discussion was the adoption of the following resolutions:

Resolved, That the interest of any exhibition of industrial products, is greatly enhanced by knowing the name and residence of the producer, and we recommend that agricultural societies adopt the practice of having the name and residence of the owner or exhibitor attached to the animal or article, together with the award of the adjudging committee, if any. We also recommend the adoption and enforcement of a stringent rule directing committees to exclude wholly from any award, every competitor who may in any manner, at any time or to any extent attempt to influence their decisions.

Resolved, That this Board recognize the advantages of large and efficient societies over smaller and weaker ones, and that where inefficient societies at present exist, efforts should be made towards consolidation, and where practicable, reduce them to one in a county.

Resolved, That the usual number of awarding committees should be reduced, when practicable, and that the several chairmen of committees be paid a reasonable compensation for their services.

The suggestion of the report that "the bounty of the State (or part of it,) be set apart and offered in prospective premiums for general farm improvements," was discussed at some length, but resulted in no definite action.

In the course of it, Mr. Perley said that as the example of Cumberland was mentioned in the report, it might be proper for him to speak of the workings of the plan in that county. For the last series of premiums offered, there were sixteen or seventeen farms entered. They were offered only two years before the premium was to be awarded, but the information was some time in spreading, so that some of those entering, had but a year and a half to work. The competition was close. All worked with commendable energy, though with not the same degree of prudence and skill. The premiums were awarded, the first, of $100, divided between two wealthy men, the second to one who had indeed a large farm, but it was the result of his own labor.

The effect of offering the premium was a great improvement all over the county. Those who commenced by ridiculing the attempts of their neighbors, had ended by following their example, in improving. He was sure that no premium offered, had been of so much advantage to the society and the county as this. They had now prolonged the time for competition to three years, and anticipated a still greater improvement in that time than had yet been made.

The business committee reported the following subjects for investigation, and they were committed as follows:

1. What legislation is needed for the encouragement of sheep husbandry? Messrs. Wasson, Cargill, Fish.

2. To what extent can substitutes for hay, as winter forage, be profitably employed? Messrs. Chamberlain, Fish, Perley.

3. Is it desirable that well-bred animals should be introduced into our State; if so, what kinds, and to what extent? Messrs. Jewett, Norton, Chandler.

4. What means should be recommended to advance the cause of Agricultural Education? Messrs. Hammond, Chandler, Weston.

5. Is any legislative action needful in view of liability to fatal contagious disease in cattle? Messrs. Goodale, Porter, Wasson.

6. The importance of farm accounts. Messrs. Cargill, Currier, Porter.

7. By what means can the natural advantages of Maine be best made known and capital and population attracted hither? Messrs. Weston, Martin, Bean.

8. Does the pursuit of agriculture in Maine compare favorably with other avocations in which our citizens engage? Messrs. Rogers, Currier, Bean.

Subsequently Mr. Cargill, from the committee on first topic, made the following Report:

Is legislative action needful to the encouragement of sheep husbandry?

Of the many inquiries suggested by the topic under consideration—calling for facts and figures—your committee only respond to that one insuperable *dis*-couragement to the keeping of sheep—the destruction of them by dogs.

From the lands of our state, of that grade not arable, considerable in extent in the aggregate, well adapted to sheep ranges, if so appropriated, an immense revenue would accrue, operating as an active agency in fostering and encouraging the industrial interests of the state. It is a truth, discouraging as it may be, that the number of sheep in Maine has been declining during the past decade, at a loss or reduction of 17 per cent., on an aggregate of 77,000 sheep within ten years, an outright loss of $154,000. Surely, none can say that the 20,000 dogs of Maine are *idle* dogs, or their owners miserly masters, while they contribute an annual sum of $15,400 to develop the dogological capabilities of the State.

England, with an area of only 15,000 square miles more than Maine, has 55,000,000 sheep—equal to 110 sheep per square mile—producing 250,000,000 lbs. of wool annually. Maine, with seven-tenths the area of England, has only 374,195 sheep, producing

1,112,525 lbs. of wool, or 2,087,475 lbs. less than are required for home consumption.

Our State in comparative rank, in area, with Vermont, would have 500,000 sheep more than her present number, or as compared with reference to population, 1,500,000 sheep. The present number of sheep in Vermont, equally distributed among her farmers, would give eighteen sheep to each; a like distribution in Maine, would give to each of her farmers less than five sheep.

In comparative rank with England, Maine would have 3,740,000 sheep, producing 8,020,000 lbs. of wool more than are requisite for home demand; or as compared with Ireland would give 3,808,000 sheep, producing 11,000,000 lbs. of wool, which would supply the wants of home, and leave an excess or surplus of 8,224,000 lbs. for exportation, worth in the market the sum of $3,289,000.

To fill the sheep ranges of Maine to their full capacity, would require about 7,000,000 sheep, producing a net income of $7,280,000 annually, a convenient annuity on which to retire to private life.

Prospective considerations may, or may not be pertinent to the subject under investigation, and we address ourselves to the inquiry, "Is legislative action necessary to encourage sheep husbandry?"

In 1850, as shown by the census returns, there were in Maine, 451,000 sheep; by the same authority, there were in 1860, but 374,000 sheep—a decrease of 77,000, or 7,700 sheep per year, an annual loss of $15,400.

For such an effect, the cause can easily be determined. Basing estimates upon the most reliable data at command, deduces the surprising truth that there are some 20,000 dogs in our State, to scatter fleas by day, and steal the sheep by night.

The official returns of Ohio, show that the damage to sheep by dogs, for 1858, was $148,748. Upon this calculation, *official*, and doubtless reliable, is based the estimated damage to sheep by dogs in our State, a fact of which few persons are aware, that 5,530 sheep are annually sacrificed to appease the appetites of these canine robbers—55,300 sheep in ten years, having a cash value of $110,600—a loss, enormous as it is, chargeable to the dogs alone, that horde of worthless curs which feast and fatten on mutton-chops. Is not legislative action needful, and the encouraging and protecting arm of the law required? A self-evident truth, purchased and proved at costly rates.

What legislation is needful to encourage sheep husbandry, the exigencies and interests of the farmer are not slow to define—that a *tax on dogs* would afford the protection asked or encouragement desired. Such a tax would work no mischief or oppression. Ohio and Massachusetts have already interposed, both by legislative enactment and its rigid enforcement, in behalf of the rights of the husbandmen in their respective States.

And in Maine, public opinion loudly calls for a law, which shall effectively encourage and defend.

In the opinion of your committee present indications abundantly warrant the belief that there is no longer a question as to the propriety of enacting a law taxing dogs as the most effectual way of accomplishing and affording the encouragement and protection desired.

Therefore we ask to submit the following resolve:

Resolved, That the injury to the sheep of the State, by dogs, is enormous, and tends strongly to discourage the raising of sheep, and that in the opinion of the Board, such legislation ought to be had as may be consistent with the provisions of the Constitution of the State, and will afford greater protection to this class of property.

SAMUEL WASSON, D. CARGILL, ELLIS FISH, *Com.*

Mr. Wasson remarked in connection with the report that it does not set forth all the statistical facts in the case. The committee have charged to the dogs only the destruction of 5,530 sheep annually; another item of expenditure—the cost of keeping—demands more than a passing notice. What is the cost of keeping a dog? Is it one dollar a week, or fifty, forty, thirty or twenty-five cents? At twenty-five cents it will amount to $5000 per week, or $260,000 per year. To this add the value of sheep destroyed, ($15,400)—equal to $275,400 for the yearly cost of supporting the 20,000 dogs in the State. A sum equal to the present year's State tax; the expense of the State Prison, the Reform School, and some $19,000 towards making up the appropriation for the Insane Hospital. Official returns indicate an annual loss of 7,700 sheep, of this number 5,530 sheep are charged to the dogs, leaving a further loss of 2,170 sheep to be attributed to disease and other causes. The statements in the report present a startling and almost incredible appearance, but as they were prepared with studious care we have but little, if any doubt of their reliability. The question now is, will legislators evince their desire to protect, as far as may be, this branch of our industry?

The report was accepted, and the resolution was passed.

Mr. Chamberlain for the committee on second topic, viz:—To what extent can substitutes for hay as winter forage be profitably employed? submitted the following remarks:

"Your committee, with the little thought they have been able to give this question here, see embraced in it, so much that lies at the foundation of successful agriculture, that we deem it our duty to respond to the Board at this time, only so far as to express our views as to what should be considered in its connection, in a detailed report.

Were we to examine it as applying to a particular locality, our inquiry would include the production of root crops,—forage produced on cultivated lands, involving the application of labor and manure, the chemical condition of food, as containing the best proportion of ligneous fibre and digestible nutritious matter,—the preparation of food by cutting, grinding, mixing or cooking,—the value and importance of a due amount of vegetable oils, and how these shall be obtained whether from oil yielding crops grown at home, or depending on purchase from abroad,—climatic influence, as effecting the hay crop unfavorably when compared with roots and cultivated forage.

But when our examination shall take into account, the wants of the entire State, additional labor is imposed,—as the value of manual labor compared to land,—want of manure, &c.

From the extended experiments already made in different countries, many valuable facts have been deduced in relation to feeding, but the conditions surrounding your committee, here, are not so favorable to an exploration for the reports of such, as they desire.

Some experiments are now in progress at home, out of which a little light may come.

With these brief remarks, touching the importance of this topic, as at present viewed by your committee, we respectfully ask to retain it for report at a subsequent day."

Mr. Martin, in accordance with the request of the committee, moved to recommit, with instructions to report to the Secretary of the Board, that the information might be embodied in his next Annual Report; which motion prevailed.

Mr. Jewett, for committee on third topic, read a report which was discussed and recommitted with leave to report subsequent to this session.

Mr. Hammond, from the committee on topic No. 4, upon agricultural education, made the following Report:

What means shall be recommended to advance the cause of agricultural education?

The committee having this subject under consideration, from a very brief examination of its merits, are only prepared to say,

That in their opinion a high state of agricultural improvement in any community will not easily be attained by practice alone, and that a knowledge of the principles upon which correct practice can be based is as indispensable to successful agriculture as in the professions of medicine, surgery or any practice based upon scientific principles.

We believe that it is now generally admitted that agriculture is a science of no mean magnitude, either in the multiplicity of its operations, the sublimity of its principles, or of its importance to the world, and we believe the time has come when young men at least, should have the means of acquiring a knowledge of those principles upon which their future practice is to be based, instead of wearing out a life of toil and loss, only to discover at last what might have been their condition in life from an early and more correct knowledge of the occupation they had pursued.

We are free to admit that the experiments prompted by agricultural societies, and the annual exhibitions of agricultural industry, and the free circulation of agricultural reports, and the extensive circulation of able agricultural newspapers have done much to enlighten the mind, improve the practice, and to dispel the prejudices against the study of, and, to some extent, induce reliance on those natural laws or fundamental principles which underlie the structure and should be made the foundation of our practice, if we hope for easy success, or expect to arrive at, or make any near approach to that perfection even, attained in other pursuits resting on similar foundations.

We are happy to say, that, in our opinion, the light already diffused in this way has waked up in many minds a desire of improvement; and, as the mists are gradually dispelled, an increasing interest is manifested in the agricultural community for that knowledge which will enable them to lay the foundation of their earthly hopes and prospects of life, in the sunlight of well settled truths, which, as far as possible, shall be accessible to all. We consider that an important point is gained, when a large majority interested admit that a strong necessity for agricultural education exists; but as to the best means of advancing this cause, which is the main question before the committee, there is doubtless a great diversity of opinions, which, in a community like ours, will tend greatly to delay, but, at the same time, may consummate a more perfect system.

To the means already in operation, as before named, a geological, or rather an agricultural survey of the State; the encouragement of a more thorough study of chemistry in our schools, and an appropriation of money by the State, to be expended in premiums on well conducted experiments to be published in the annual reports of our Secretary, would be considered by your committee important auxiliaries to the means now in operation to advance agricultural education. Yet we cannot conceive that the knowledge of any science which is to be the foundation of important practice can be obtained and diffused so speedily and with less expense than by the usual long tried and matured means of the same system by which all other professions have acquired their present positions throughout the civilized world.

Institutions where science is taught and demonstrated by practice, and new truths developed by experiments and diffused as far as practicable through our common schools, must be the best means by which agricultural education can be advanced so as to be of the greatest use to the greatest number. And if we are correctly informed upon this subject, this is the conclusion arrived at in the older countries of Europe, after mature reflection, and has proved successful; and we shall not have to wait long to learn the results of this system in several States of our Union.

We are well aware of the expense and difficulties to be overcome in the establishment of such a system, at least, in its commencement. Yet, from a very brief consideration of the extent of good farming land in our State, with the inducement to agricultural pursuits, from the fact that a great variety of occupations is afforded by her extensive seaboard, pineries, slate and iron quarries, and facilities for manufacturing, which must always secure a good home market for all surplus produce, the consideration of expense sinks materially, when compared with the difference between a very perfect and a very imperfect system of farming. We have been induced here to make a very hasty calculation, which we believe falls far below the real difference.

We set the number of farmers in the State down at 50,000. Now will any intelligent farmer in the State say that, from past experience, he believes that even with a limited additional knowledge in agricultural science, the chemical combinations of plant sustaining elements, the proper mixture of the soils required in order to get at the full extent of their capabilities; also in the application of fertilizing substances to the best advantage, he could not have saved twenty dollars? And if so, then it follows that with a little more perfect knowledge of the system we are considering, $1,000,000 might have been saved in the State to the farmers this year.

This calculation may appear, from the first impression, an exaggeration, but we think mature reflection will increase the same.

We believe that such an institution would tend to induce immigration from abroad, and retain our own citizens at home. We believe, also, that such an institution can only be put in successful operation by an act and an appropriation of means by our Legislature, when public opinion shall have been favorably impressed with its importance. To this end, if our views are in accordance with the views of this Board, it will be their duty, through their Secretary, and the press, by addresses or any means at their command, to keep this important subject before the public.

Such an institution is not, by any means, to relieve agricultural organizations from responsibilities and efforts to develope new truths and facts in the great science of agriculture, and to disseminate the same by all the means within their province; but to cooperate with, and serve as the great centre whose more perfect light we may use and reflect.

But while we wait for the development of institutions recently established, and the favorable or otherwise, impression on the public mind, we would call the attention of this Board to the suggestions in this report relative to an agricultural and geological survey of the State, and the introduction into our common schools of agricultural chemistry, and particularly to some regular system of conducting experiments that will be successful, and that may be accessible to the community, which in our opinion, might materially advance agricultural education.

E. L. Hammond, *for the Committee.*

In the course of a discussion which took place, Mr. Wasson offered the following resolve:

Resolved, As the opinion of the Board, that an elementary work on agriculture should be introduced into and used in our common schools.

Mr. Perley said that at first sight the resolve struck him unfavorably. There is a great difficulty in the frequent changes of books treating upon the same subject. This is introducing a *new* book and a new subject, providing an education for one particular pursuit, and might not meet the wishes of a majority of the people. All should receive an *elementary* education, whatever occupation they may choose to pursue. But, beyond this, the farmer requires a *special* education to fit him for his employment. This can only be obtained in schools devoted exclusively to this object.

Mr. Bean favored the resolve. A short time ago, algebra could not be taught in our common schools. Now it is taught throughout the State. He thought a work on agriculture should be introduced as well, but not allowed to interfere with other studies.

The prejudice against book farming was fast dying out. Formerly, it was difficult to persuade farmers to take any book upon the subject of farming. Now it is entirely changed. Even boys are eager for all the information they can obtain on the subject. He hoped some action would be taken to increase the facilities for obtaining a knowledge of agriculture.

Mr. Hammond agreed with Mr. Bean. All have agreed that an agricultural education is necessary, and this seems the most feasible plan.

Mr. Porter said that he had always been in favor of giving those who are going into farming an education. By means of agriculture and chemistry taught in the common schools of Scotland, he had known some to rise to be first class land-stewards in that country. They had become interested and pursued the study.

Mr. Goodale said there was no possible doubt of the value of agricultural education. The doubt attached only to the mode by which it may best be effected. Of the many schemes proposed, two stand out more prominently than others. One is the establishment of agricultural colleges, where the pupils should have the best possible instruction, illustrated by experiments and demonstrations, both in the laboratory, in the stall and in the field—science and practice hand in hand. When the course of instruction has been gone through with, the graduates go out and become so many points from which light is diffused to others around them, both by teaching and example, and many more are benefited than the comparatively small number who directly enjoy the college instruction.

The other mode is by introducing the study of elementary works on agriculture into the common schools, and in this way, insure a smaller amount of direct instruction to a much larger number. Mr. G. thought both should be adopted—that agriculture should be taught in colleges, high schools, and also in common schools, to such as desire it and have obtained a tolerable familiarity with the indispensable reading, writing, grammar, arithmetic, &c., which all need, whatever be their future calling.

If we cannot have all, let us have what we can, and on the whole he preferred to begin at the common schools. But there is a difficulty here. The proper book for the purpose does not yet exist (so far as he knew.) The nearest he had seen, was Prof. Johnston's Catechism of Agriculture, and this was written some years ago, and needed alterations to keep pace with recently acquired knowledge regarding the principles of agriculture; but let there be a demand, and doubtless ere long the right book will be published. Indeed, he had understood that a work of the kind was in preparation under the auspices of the Massachusetts Board of Agriculture.

The resolve was adopted and the report accepted.

The committee on topic No. five through the secretary, made the following Report:

The committee charged to inquire whether legislative action be needful regarding fatal contagious disease in cattle, report

That, during the year past, the herds of the neighboring State of Massachusetts, have suffered from a contagious and incurable disease, introduced by means of animals imported from Europe; that the threatened destruction of the agricultural prosperity of that State was arrested by prompt and vigorous measures, and at a heavy cost. We find that a considerable item of this cost was the expense incident to a special session of the Legislature, rendered necessary from the fact that no existing enactments were adapted to and adequate for the pressing emergency. We understand from authority deemed reliable, that this disease exists in Europe at the present time, to as great an extent as heretofore, and that the liability to its introduction hither, is as great as in any previous year. Your committee find that wherever this disease exists abroad, stringent measures to prevent its spread have uniformly been found necessary and have been adopted by various governments.

In view of these and of other facts, and also of the consideration that no alarm or excitement exists at the present time, and legislation may be calm, deliberate and inexpensive, we recommend that a law be enacted, which may be suited to the very possible and fearful contingency here contemplated.

We further recommend that this Board memorialize Congress on the subject, praying for a law calculated to prevent the introduction of the disease in imported animals, by means of inspection, quarantine, or other suitable means.

S. L. Goodale, *for the Committee.*

The report was accepted and the committee was directed to draw up the memorial to Congress contemplated, and present the subject before the Legislative committee on agriculture.

Mr. Cargill, from the committee on topic No. six, "The importance of Farm Accounts," made the following Report, which was accepted:

Importance of Farm Accounts. In presenting a Report on the above topic, we do not expect to meet the views of all, and perhaps but few will agree with us. Yet we do think the subject one of much importance to every one who wishes to excel, or even to have ordinary success in that noble calling—cultivating the soil.

All admit the indispensable necessity of those who engage in mercantile pursuits, to keep accurate accounts, if they would succeed. The mechanic is expected to keep an account of his business, even if it is on a small scale. The day-laborer would be thought to be quite negligent, if at the close of the day, or at least the week, he should not make a reckoning of what he had accomplished. Yet there are probably tens of thousands of *would-be-farmers* in this State that keep no account whatever. And there are probably as many more, who keep their accounts in such a manner, that it would puzzle a live Yankee to find out anything by them, if the maker was not present to explain them.

There are some noble exceptions to the foregoing—we have some farmers that are well posted. What we think is important to a right start in this matter, we will endeavor to state briefly. Perhaps we can get at the subject the best way by taking the case of one who has just purchased a farm.

At the earliest practicable time, let there be as accurate a plan drawn of the whole farm as may be—noticing all peculiarities that it may contain—hills, springs, rocks, &c., &c. Then let there be an inventory made of the cost of the farm, the stock in all its minutiæ, tools of all kinds, seeds of every description,—which is to be *the* stock in trade, and will form one part of the account. Then let there be a careful and strict account kept of all labor done on the farm, such as erecting buildings and fences, or repairing the same, putting in drains, clearing lots, reclaiming exhausted lands, setting and rearing orchards, putting in, cultivating, harvesting and marketing crops, and in fact, keep a minute account of all the ramifications of the farm.

Do we hear any one say, what is the use of all this? Much every way. In the first place, it will give an idea of the possessions you have. In the next place, it will afford you a good opportunity to calculate what may reasonably be expected of you. In the next place, if you are keeping your accounts as you should, you will see your true standing—whether you are making progress or not. And if you should find at the close of the year that you had not made that advancement which you had hoped to, at the beginning, you may be able to change your course, and prevent your temporal ruin. If on the other hand, your success had been equal to your expectations, it would give you great courage, lighten every burden, give pleasure to many an hour that otherwise would be almost a burden.

What we have said about the one who had just purchased a farm may be applied to any one, however long he may have been in his present location.

At the beginning of the year, when most of the farmers have the greatest leisure, the plan may be drawn, an account of stock taken, and all made ready, so when the busy days of spring and summer come, the work of keeping the daily account will be light.

We think if our farmers could be induced to go into this matter of farm accounts, we should see a marked difference. Where now we see a neglected, run down farm, with all its unsightly appendages, we should see the neat farm buildings with all the appearances of thrift and comfort—indications of a happy, happy home.

D. CARGILL, JOHN CURRIER, HUGH PORTER, *Committee.*

Mr. Perley was in favor of the adoption of the report. The necessity for keeping farm accounts is too little understood. A journal of work and crops should be kept. If a team is at work, set down in the journal at the close of the day the amount and kind of labor performed; in short, keep an account of everything done, so that one can tell, when the account has been made up, whether it will be profitable to raise a crop of the same article another year. He cited an example of the importance of keeping an account. He had to pay a year ago about thirty cents a bushel for threshing his wheat and barley by hiring a machine, and feeding and keeping the men and teams. He found that he must economize, and accordingly hired two men last fall to thresh in the old way, and found that the cost was only six cents a bushel for barley, wheat not yet threshed. Accordingly, he should give it as his opinion that farmers who have only a small amount of grain to thresh, should have it done with flails instead of hiring a machine to do it. He believed that the keeping of an account was as necessary as any other part of the business of farming.

Mr. Porter said that since he commenced farming, he had kept an account of everything. He took bills of everything bought, and kept an account of everything sold, even to the most trifling article. He could thus look back to any year and find exactly how much he had gained or lost. This, in his opinion, is the only way to get along. It was also a great benefit to the farmer by keeping him fresh in the habit of writing. If any man found that he could not make farming pay, after keeping a strict account, he should advise him to leave the business.

Mr. Rogers liked the report very much. He feared, however, that the importance of keeping a system of farm accounts was too little impressed upon the minds of farmers. It would be a great saving to them if they would adopt it.

Mr. Goodale said that if a farmer would keep only a record of each day's transactions, it would soon lead to habits of thought, and cause them to make closer calculations. He had asked the most successful dairy farmer in the State how much more a pound of butter cost than a pound of beef, he could not tell exactly but said that he could obtain a pound of butter about as cheap as he could a pound of beef. How many farmers could answer such a question? but they ought to be able to. Every one should be able to tell what he can make in any particular branch, and follow that in which he can best make a living.

The report was unanimously adopted.

Dr. Weston, for committee on seventh topic, submitted the following report:

By what means can the natural advantages of Maine be best made known, and capital and population attracted hither?

A mere superficial glance at our broad domain, with its ample coasts, spacious bays and harbors; with its numerous rivers at convenient distances, extending their long branches far into the interior, and abounding with many a busy water-fall; with its fertile meadows, broad fields, swelling hills and ancient forests, must convince any one of its facilities for commerce, manufactures, and agriculture.

But notwithstanding our almost incalculable resources, if we consult the statistics of our population from 1790 to 1860, they disclose the fact of a gradual decrease of percentage during every decade. In 1800 the increase of population the preceeding ten years was 57.16 per cent.; 1810, 50.74; 1820, 30.45; 1830, 33.89; 1840, 25.62; 1850, 16.22, and in 1860 but 6.86 per cent. From these census returns, it is apparent that the average decennial increase, from 1790 to 1850 was 35 per cent., and that the increase the last ten years has been less than one-fifth of the average for the sixty preceeding years. A comparison of the recent returns from the several counties, show that Aroostook and Penobscot have each made a larger gain in population than all the State west of the Kennebec River, and both together have gained almost as much as all the other fourteen counties, indicating that our future principal increase may naturally be expected in the unsettled territory of the north-eastern portion of the State.

During this same period, many of the western States possessing no more productive soil than our own Aroostook valley have increased in population and wealth and influence at a rapid and constantly accelerating rate.

Under these circumstances, the inquiry pertinently occurs, how can this downward movement be arrested? how can new energy and vitality be infused into a State which has prematurely begun to evince symptoms of approaching decay? Our power of recuperation, our own resources must be discovered.

An all bountiful Providence has conferred upon us a large estate, equal in extent to all the rest of New England. It is believed to contain undiscovered minerals and metals, quarries of granite, marble, slate, lime, and perhaps coal; it is supposed to contain a great variety of materials very useful in the arts, manufactures and agriculture, and as we ourselves, from our education and varied avocations are not qualified to search successfully for them, we need an agent whose mind has been disciplined by scientific training, whose eye has become keen by investigation and practice in past explorations, to make a minute and extensive scientific survey of the State, embracing its geology, agricultural resources, natural history and physical geography. It is believed that "such a survey, ably conducted, and faithfully reported, would greatly tend to develope and improve its agriculture, determine its mineral wealth, increase its mechanical and manufacturing interests, and assist in supplying our educational wants; and that it would moreover attract population, capital and enterprise from abroad."

The future welfare of the State requires prompt and speedy action on the part of the Legislature to initiate steps which would secure so desirable a consummation. In view of the possible results to be attained by such investigations and reports, the cost should not be regarded, for by means of them, doubtless the aggregate wealth would ultimately be largely increased with a correspondingly increased revenue from taxable property. The utility and value of such explorations are no longer doubtful. New York, Virginia and Massachusetts have expended thousands in this way and realized millions. Many other States have had partial or general surveys, and such have been the resulting advantages that the cost has been forgotten, the expenditure never regretted.

An appropriation of $4,000 or $5,000 a year would undoubtedly secure the service of some young man who has had a thorough scientific education, and some practical experience, and the necessary assistants.

Having a reputation to make, such an individual for less compensation would enter upon the work with zeal and ambition, and would prosecute it to successful completion. The season when such investigations can be profitably conducted is not long, and by selecting and improving the best months for the purpose, the enterprise can be more economically prosecuted.

More than twenty years ago, a survey was commenced by Dr. C. T. Jackson, and continued some three years, and the facts ascertained were published in three annual reports. It was then suspended. This was a mere beginning. It was necessarily very imperfect. It was chiefly confined to the towns on our seacoast and rivers, and a few of the more populous towns of the interior; still it was not an unprofitable investment. It attracted attention to our resources; it intimated that vast wealth exists beneath the surface of our soil only awaiting discovery to contribute to our growth and prosperity; it disclosed the richness and fertility of our unoccupied land; it ascertained by analysis the deficiencies of some soils, and the materials in the neighborhood to remove their barrenness. It may serve as a basis for future operations. This work needs to be speedily resumed and conducted more minutely, and more thoroughly, under the superintendence of some scientific man who will enter upon this undertaking with enthusiasm, and with an eye to all our industrial pursuits as well as to his own compensation.

The crust of the earth is largely composed of rocks of different groups and ages, some unstratified, being aggregates of mineral substances mingled together; others stratified or arranged in concentric sheets like the layers of an onion. The rocks, which exist in strata, are considered as sedimentary deposits from water, originally arranged in regular horizontal layers. In process of time these sheets, by various agencies were tilted up so as to incline at various angles from the original horizontal line, and expose their edges. Rocks are again divided, according to age, into primary, transition and secondary. By the action of air, water, varying temperatures snd chemical laws, rocks have been decomposed, soils have been produced, and rendered fertile by a proper mixture of mineral ingredients with animal and vegetable matter; and so we have the tertiary formation. Then we find the diluvial deposit, the work of a long past deluge which has swept along the loose materials in its way, and left them far from their original beds.

A geological survey signifies an examination of the nature and situation of these various strata. It determines the kinds or species of rocks, their arrangement and relative age, the ores and minerals which are their associates, their extent, their value as articles of merchandise, and the agricultural characteristics of the several localities.

Many of our rocks, minerals and soils, have a positive pecuniary value. Maine has inexhaustible quarries of granite favorably situated on navigable waters. They need only to be discovered, made known, and wrought to furnish building material enough for the whole world. The southern and western States are entirely destitute, and need abundant supplies. Massachusetts, which expended liberally for a survey is realizing a bountiful reward from this demand. Her granite quarries have yielded more than all the gold mines of the southern Atlantic States. The granite on our seaboard has been partially explored, but that of the inland localities is yet to be examined. As it is difficult to transport this heavy material by land carriage, and as it is everywhere needed, it is important that it be discovered in every township where it exists. For strength, durability and beauty, it stands at the head of all building materials.

Marble, particularly that highly prized variety called serpentine, or verd-antique,* has been found in considerable quantities. If it can be wrought to advantage, it would become an important article of commerce. It requires farther investigation. Epsom salts, magnesia and venetian red can easily be manufactured from it, and hydraulic cement from green marble. Free stone in great quantity exists, and may be advantageously quarried for buildings.

Maine surpasses all other States in the abundance of its limestones. Its manufacture into lime in Rockland and vicinity, has given employment to a large population. Its transportation has furnished freight to a numerous fleet of coasting vessels, and supplied all our Atlantic cities with this necessary article. Doubtless, enough can be found in other localities in the interior for the improvement of soils and other purposes.

It is supposed there is slate enough on the banks of the Piscataquis to cover the roofs of every building in the country. If the cost of transportation should be materially reduced by the construction of a railroad from Bangor to that region, it would be used in preference to any other, being inferior to none; and the general demand for it would bring into existence a thriving manufacturing village, which would stimulate agricultural industry, and make an additional home market. It is important that the full extent of this quarry should be ascertained, as it is probable that only a small fractional part is yet known.

Mica slates, used extensively for side-walks are abundant. Milk-white quartz has been discovered in large masses, which might profitably be made into excellent flint glass, also granular quartz and pure white sand, well adapted for the manufacture of window glass of the best quality.

Felspar abounds, superior to that used for making the famous Sevres, porcelain and china ware, and it only requires skill and experience to make such ware equal to any foreign importation, and sufficient for the demand of every family.

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* See Jackson's Second Report on the Geology of Maine, pp. 128.

Marl, a substance very useful as a manure, occurs abundantly under peats on many of our lowlands.

A geologist never wastes his time in looking for valuable ores or minerals where they are never found. He has learned by study of the accumulated facts of the past, and by his own observation, that certain rocks contain metalliferous veins and beds, others combustibles. Hence he prosecutes his researches accordingly. He seeks coal in the newer stratified rocks, iron ores in other species of rocks, bog iron ore in alluvial deposits, different ores in different geological districts or formations. Iron ores more precious and useful than gold and silver, have already been discovered in the State, as rich as any on the globe, and doubtless more may be found. It is necessary to ascertain their number and extent, and whether they can be profitably wrought. There are also indications of coal and tin. Lead, zinc and copper are known to exist. Simply to name these is sufficient to indicate their value. Copperas, alum, and many other useful salts and pigments may be manufactured from copious materials.

Our geologist in his work will collaterally examine the water power of rivers, and report upon its adaptation for manufactories; he will naturally become acquainted with our wild animals and birds, and may describe them, and also mention those which should be cherished and protected on account of their utility to the agriculturist, especially those birds which devour destructive insects and worms. He notes also the peculiar botany of the several districts under examination. Thus he may make valuable contributions to useful knowledge.

But while he pays due regard to the prosperity of art, manufactures and commerce, his chief object will be to subserve the more important interests of agriculture. He will divide the territory into zones of vegetaton, according to the peculiarities of each geological district in which the same vegetable and animal matter may be present; but the soils have different mineral ingredients, because they were mainly formed by the disintegration of different rocks, as granite, or limestone and slate, or trap; he will also mark the tertiary and alluvial deposits, and will describe the crops which will flourish best in the several localities. He will show how the temperature, the climate of each section, is influenced by comparative elevation, the near presence of mountains or large bodies of water; also how useless bogs and swamps may be reclaimed by underdraining and the use of some ameliorating material, and how meadows and wet uplands may be improved. He comes to the assistance of the farmer when his land is barren, analyzes his soil, ascertains its composition, and prescribes some material to render it fertile. If too sandy, it may need clay; if too plastic and tenacious, sand; or if it contains copperas which is destructive to vegetation, he recommends lime, which converts the deleterious ingredient into a fertilizing manure, and all plants henceforth thrive with great luxuriance. These are mere illustrations of what may be accomplished in hundreds of instances.

One of the most attractive portions of the State, which deserves exploration in all its length and breadth, is the valley of the Aroostook, and a tract extending south some fifty miles, drained by the tributaries of the Penobscot and St. John, and embracing the five most eastern range of townships.

This territory comprehends an area of more than two thousand square miles. Here we find a soil, which originated mostly by the decomposition of slate and lime, rich in vegetable mold and rivalling in fertility the best settling lands of the West. The subsoil is so porous that surplus water readily passes through it in the wettest periods, obviating entirely the necessity of underdraining. The land is susceptible of cultivation very early in the spring. Snow falls in November before the ground has frozen much, remains all winter, affording ample protection to the grass and winter grain, and when it departs, the soil can be tilled immediately or as soon as that of a more southern clime, and vegetation comes forward with remarkable luxuriance and rapidity. This land is capable of producing wheat and other grains in great abundance. Its deep alluvial soil exhibits unmistakable evidences of great inherent fertility, having yielded without manure in several instances, alternate crops of wheat and oats for a series of years, with no perceptible diminution in growth and productiveness. The stalks of grain often attain an unusual size and height, sometimes stretching above the heads of the inhabitants. It contains iron of the best quality, and other valuable minerals. It is of moderate elevation above the level of the sea, and on this account possesses a milder climate than the more hilly and mountainous portions of the State, for it is a well-known fact of physical geography that an altitude of three hundred feet is equivalent in its effects to a degree of more northern latitude. The whole region is uncommonly salubrious. In consequence of its more uniform temperature, it is favorable to robust health and longevity. Consumption very rarely prevails.

The character of this whole country presents the strongest inducements to immigration and settlement; but unfortunately it is far from the great centres of population, far from the terminus of our railroads. If we would turn the current of immigration which has been setting westward into our own channel, we must first provide the channel. A *railroad* is imperatively demanded to make this territory more easily accessible to teeming thousands of industrious inhabitants. We have reached a point from which there must be either progress or retrocession. Shall we advance or recede? A thorough survey of the State to reveal all our natural resources, and the construction of an iron highway to give access to those resources seem to be the most feasible modes, in this emergency, to attract capital and population hither. Look at Illinois. In 1852, there were only ninety-five miles of railway in the State, and a population of 851,000; but in five years she had completed 2,410 miles of road, at a cost of $15,000,000, increasing her population to 1,300,000, or 53 per cent.; and during the same time, advanced the value of her wild lands from $1.25 to $10 per acre.

You cannot travel on the great western thoroughfares or in Canada without seeing pamphlets describing the natural advantages of Illinois, her great central railway and connections, the price of unsettled lands along its route and all the information deemed necessary to inspire an interest. These are distributed so freely that he who runs may read. They are the first things that greet the eye of the emigrant from Europe on his arrival in our large cities, and they are placed in the hands of agents and consuls in foreign lands.

Shall we supinely sit still, or shall we arouse and imitate her example? Then, and not till then, can we with propriety ask our fellow men to go with us and possess this good land, with any assurance that they will heed our invitation. But having performed the duty incumbent upon us, with proper efforts the gentle Norwegian, the industrious German, the quick-witted Irish, the sagacious Scotch, the plucky Englishman, and the energetic Yankee may be persuaded to dwell together harmoniously in our common territory, and form a vigorous race of men, possessing all these desirable characteristics. "Then the wilderness and the solitary place shall be glad for them; and the desert shall rejoice, and blossom as the rose."

From these several considerations, it must be apparent that a scientific survey is eminently desirable, as it will greatly benefit all branches of industry. It will discover and make widely known our unrivalled water power, the abundant raw material awaiting skillful hands to mold it into useful fabrics, the quarries and ores to employ our vessels, the means for greatly ameliorating our impovished soils, and the lands most attractive for settlement. The reports of such survey will serve as materials from which interesting text books, for our schools and academies, may be prepared on the topographical, economical and agricultural geology of Maine, its physical geography and natural history; and our young men, having become versed in these branches of knowledge, and in agricultural chemistry and vegetable physiology, may afterwards prosecute farming more intelligently and more successfully. As capital is both conservative and discriminating, we must first prove that it can safely and profitably be invested in certain specified localities; then it will be attracted to them by the force of a law as potent as the attraction of gravitation; and there populous manufacturing villages will grow up which will demand new supplies and stimulate the generous earth to increased productiveness. Thus manufactures and agriculture are mutually dependent and react upon each other in infinite progression, and both employ and contribute to the prosperity of commerce.

Respectfully submitted.

J. C. WESTON, ROBERT MARTIN, JOEL BEAN, *Committee.*

The report was adopted.

Mr. Rogers, for committee on eighth topic, submitted the following report:

Does the pursuit of agriculture in Maine compare favorably with other avocations in which our citizens engage?

That there has been a disposition in the minds of a large portion of the commuity to undervalue the farming interest is very evident, and we are sorry to say, the idea has to some extent pervaded the minds of farmers themselves, that their occupation is not so reputable or so honorable as some other calling.

But we are happy to believe that the true position of the agriculturist, among the other callings and pursuits of our citizens, is becoming better understood and appreciated in the community than it has hitherto been. Farmers themselves are beginning to awake to a sense of the position which they occupy in society, and to the dignity of their calling. It is now generally acknowledged that the prosperity of agriculture is indispensible to general prosperity. It is the great movnig power of human existence.

As we have said, there has been a disposition among farmers themselves to undervalue the many advantages which they enjoy, and to consider the labor of conducting the operations of the farm as a kind of drudgery. But if that be a drudgery, what shall we call the daily labor of the mechanic, or the dull routine of the grocer or dry goods dealer, or what the confinement of the law office or counting room?

The employment of the farm is not drudgery. The farmer, while cultivating the soil, breathes the pure air of heaven, in the school room of nature, and if an apt scholar, he will study her ways, profit by her example, and be led to the consideration of the beauties which she is constantly presenting before him. The true farmer finds, not only employment for his physical powers, but for his mental faculties, and as another has justly remarked, "by studying nature he becomes practically a natural philosopher." To be successful he must conduct his operations according to nature's laws. There seems to be scarcely any other occupation in life which so naturally tends to lead men's minds to look "through nature up to nature's God" as the pursuit of agriculture. There is no more honorable or ennobling pursuit, and in the opinion of your committee, there is none, that will more surely lead to a competence, if followed with ordinary industry, economy and discretion. It has been ascertained that about 95 per cent. of those engaged in mercantile affairs in the city of Boston become bankrupt. How is it with the farmers of Maine? Large numbers of them have commenced farming with no other capital than their own physical powers, combined with energy and good sound common sense, and have succeeded in rearing and educating a family, and in securing a competency against a time of need. The cases are rare where a young farmer of good health and habits, fails of acquiring a competence, and of establishing for himself and family a pleasant and attractive home. (This last remark will apply with much force to the northern portion of our State, where land of the best quality is better than given to those that settle thereon.) We know it requires patient industry and careful economy, and it is in that way only that the merchant succeeds.

It cannot be denied that too many of us who claim to be farmers, and who live from our farms, conduct our business in a loose, haphazard, indefinite kind of way; in a way that would inevitably bring ruin upon a man engaged in any other business, and following it in the same thoughtless manner, without regard to any definite plan, and keeping no account of the expense of the operations or of the profit or loss derived therefrom.

Farmers ought not to expect to succeed without studying their business, and prosecuting it with the same energy and zeal, and with plans as well matured, as those do, who succeed in any other business. The very fact of their getting a living is an argument to prove the business good, if properly conducted. We would not presume to say that the farmers of Maine, even under the most favorable circumstances, can realize such fortunes as sometimes fall to the lot of those engaged in mercantile or other pursuits. But *we do* say that of a given number of persons of equal ability, one-half engaging in agriculture, the others in the different pursuits of life, many more of those engaging in agriculture will succeed and become independent than of those engaged in the other pursuits.

Farmers have a longer lease of life than any other class of persons. By official documents of the State of Massachusetts, extending through a series of years, it appears that the average age to which printers and machinists live in that State, is 37 years; painters and tailors 42 years; blacksmiths 51 years; doctors 54 years; lawyers and ministers 57 years, while farmers average 64 years. Surely life and health are considerations which no rational man would exchange for dollars and cents.

The farms of Maine are the laboratories from whence have emanated many men of distinction in our national government, and to the farmers is our State indebted for a large proportion of those who have become distinguished among us either as statesmen or men of business. Farmers, as a class, have the means of enjoying more of the real blessings and comforts of life than almost any other class. It is true that the farmer is obliged to work, and at times to work hard, for, as poor Richard says, "he that by the plough would thrive, himself must either hold or drive." He not unfrequently finds himself at night fatigued with the labors of the day; but he can rest and refresh himself amid the social and domestic enjoyments of home, surrounded by his own family circle, and when he lays his head upon his pillow, his rest is sweet. The howling of the winter's storm and tempest does not disturb him. His flocks and herds are comfortably housed and well fed, and so is he and those dependent upon him. He keeps his horse and carriage, and whenever he and the good wife wish to spend a holiday or visit a friend, they can do so, and not feel that they are taxing themselves beyond what they are able to bear.

How is it with those engaged in other pursuits? A large proportion of them can ill afford to leave their business and hire a horse and carriage to ride out and refresh themselves when they have become weary of the drudgery and cares of business, or their wives become enervated by the ceaseless routine of housekeeping.

Let us look for a moment into those vicinities where the people depend wholly upon farming. Generally we find the farms improving, the houses neat and tidy, the spacious barns well finished and furnished, the stock sleek and fat, and the owners quite as independent and much more free from anxious care than the millionaire of New York or Boston.

We would by no means recommend all to become agriculturists. A healthy state of things requires that the business population be suitably divided among the various avocations in life. It is as necessary to have consumers as producers.

A man, if he is shrewd and fortune favors him, may secure a much larger amount of wealth, by some fortunate speculation or some lucky stroke of business, than he can possibly do by farming in Maine; but he should remember that the chances are against him.

Your committee do not believe that great riches is all that is desirable in this life, by any means. Taking all things into consideration, the probabilities of health and length of days, the freedom from anxious harrassing cares of business, domestic happiness and the joys of home, the moral influence exerted upon our children, the promise of the Almighty himself of a seed time and a harvest, we do think the pursuit of agriculture will compare favorably, yea, is more desirable to engage in than almost any other avocation.

In order more fully, if possible, to convince the incredulous, we have gathered from the census returns of 1850, statistics, showing the number of the male population of Maine that are engaged in all other avocations, also the aggregate value of farms, farm implements and live stock, and compared it with the whole valuation of the State at that time. These statistics show:

Number of farmers,	77,016	
Persons engaged in all other avocations,	85,695	
Total male population,	———	162,711

Value of farms,	$54,861,748
" of farming implements,	2,284,557
" of live stock,	9,705,726
Total value of farms, implements and stock,	$66,852,031
The whole State valuation at that time was	100,037,696

From these statistics may be seen at once the importance of the farming interest, and the relative wealth of those engaged in it, as compared with the wealth of the State.

It will be seen that less than 50 per cent. of the population are engaged in agriculture, and that they represent more than 60 per cent. of the wealth of the State.

All of which is respectfully submitted.

GEO. A. ROGERS, JOEL BEAN, JOHN CURRIER, *Committee.*

Mr. Martin liked the report. He believed that wealth did not consist in the dollars and cents possessed by a man, but in his happiness. He believed also that the pursuit of agriculture was better suited to the production of happiness than any other calling. Farmers, as a class, enjoy life better than others. The farm is a nursery for men of integrity and usefulness. The greatest men, the best men that ever lived have been raised on farms. Less than two per cent. of the inmates of the State Reform School, for the support of which, the farmers contribute nearly two-thirds of the funds, are the sons of farmers.

Mr. Goodale did not deem the fact that a large proportion of our population was engaged in agriculture, a proof of its being profitable, but rather otherwise, and the greater the proportion of those engaged in other pursuits to those engaged in farming, the more prosperous, he should conclude, will be the condition of farming; the greater the proportion of consumers to those employed in supplying the demand, the more lucrative is the employment. If we could show that farming is the most remunerative of all employments, the tendency would be to induce a larger number to engage in the business, and the supply becomes too great for the demand, and the price of farm products is brought down.

The fact is, all that the business of farming can ever become is an amply remunerative one. Its healthiest state is when the number engaged in it is not too large, compared with the number of consumers. It is not therefore for the farmer's interest to induce too large a number to engage in it.

Wealth is not indicated by the absolute amount of property a man possesses. A man is rich only by comparison, only because he has more than those around him. In the country a man who has property to the amount of $50,000 is considered rich. If he goes into a large city where there are men worth a much larger sum, he is considered only a man of moderate means. What we want to show, therefore, is that a farmer by attending faithfully to his business can get a good living.

Mr. Rogers said that the object of the report was, mainly, to produce a proper feeling in the minds of farmers as to the dignity of their calling. There has been a disposition on the part of some to undervalue it and cast ridicule upon the pursuit of agriculture.

Mr. Perley remarked that the wording of the report pleased him. The question discussed, was not whether the prosecution of farming compared favorably in *dollars and cents* alone, but in every respect, with other pursuits. It was devoted to show that farming is as honorable as other vocations, and is the source of much good to society.

Mr. Chandler thought that as there is a stong tendency to desert the pursuit of agriculture for other employments, we could not too strongly urge our citizens to engage in it.

The report was adopted.

Mr. Chamberlain reminded the members who were present at the previous session, of a mutual promise to make some agricultural experiment, and report at this session. He stated that he had made choice of crushed bones for his experiment. The protracted drouth operated to prevent any visible effects from its application. He also directed his attention to ascertaining the amount of green corn fodder per acre; and read the following paper:

"Planted the last week in May, 1860, *western flat corn*, one-half bushel on a piece 120 feet by 47 feet—being the fraction of a rod over one-eighth of an acre—or, at the rate of seed very nearly four bushels per acre. Planted in drills, five drills in a rod. Sept. 3d, cut the piece and secured it for dry fodder. Measured two separate square rods, being each of five rows one rod long, and found the green weight of fodder 298 pounds, and 330 pounds, respectively. This piece had attained the height of about six feet. The two previous crops on this piece were of the same kind. The dressing had each year been light. The condition would only have secured a moderate crop of corn. Planted at the same time with the above, a piece with the same seed, in drills of the same distance,—seeding less,—say from two to three bushels per acre. Cut one square rod on the same day as above, Sept. 3d, and found the weight 316 pounds. This piece had an average height of 8 feet. The average of these three rods gives, at the rate of 24 tons, 1866 pounds per acre. Weighed a small bundle of the coarser stalks, 30 lbs., and one of the finer, 18¼ lbs., and hung them up in a dry room. Weighed again Jan. 11th, 1861, and found the bundles 8¾ and 5 lbs., showing a loss of nearly 71 per cent. and 72 per cent. respectively. The largest stalks, originally about an inch in diameter, contained considerable moisture at the last weighing. Taking the shrinkage at 72 per cent., and the above weight per acre is reduced to six tons, 1966 lbs., or seven tons per acre of dry fodder.

I have had fodder yielding considerably heavier than the above, of last season, and think it better to plant in drills of less distance to secure a heavy yield."

On motion of Mr. Wasson, it was ordered that the Secretary of this Board be instructed to request of the Secretary of State certain statistics furnished under an act approved March 17, 1860, for the use of this Board.

This request was acceded to and the returns furnished. They were however, found to be very imperfect, and so of little use. Some apology may be found for their imperfection in the fact that this is the first time such statistics have been required, and that the blanks were in many cases sent out to selectmen after they had taken the annual valuation, and so would require much unusual labor to fill properly. It was evident however, in many cases, that neither the value of such statistics, nor the importance of careful and diligent attention in collecting and returning them were properly appreciated by the town authorities charged with this duty.

On motion of Mr. Hammond, the following resolution was adopted:

Resolved, That in the opinion of this Board, a railroad, leading from Bangor up the Penobscot, and connecting with the St. Andrews road by the most convenient route, would greatly induce immigration from abroad, facilitate the settlement of our wild lands and advance the general interests of our State.

The following resolves having been communicated to the Board by the Trustees of the West Oxford Society, were read:

"*Resolved*, That we believe the usefulness and efficiency of our agricultural societies, and especially of their annual exhibitions, would be greatly increased by establishing a similar system of representation and connections, to that existing in our military, political and ecclesiastical organizations.

Resolved, That the Board of Agriculture be invited to initiate some plan leading to this result.

The object of the Maine State Agricultural Society is, to improve the condition of agriculture, horticulture, &c., in the State; and for this purpose it receives money from the treasury, contributed by all the citizens.

Experience has shown, however, that its annual exhibitions fail to draw out the productions of the *entire* State, being mainly composed of contributions from a few large towns and cities, and from neighboring farmers and mechanics.

Ought not the *entire* productive industry of the State to be represented at each exhibition, and if it is not, is it not a fault of the system, that can be corrected?

It is also apparent that the occurrence of the annual election, and of the equinoctial storm, (sometimes protracted) render the month of September unfavorable for an exhibition, while the pressure of the harvest, at that time, confines working farmers at home.

Can no more favorable time be selected?

It is believed that the Board of Agriculture, by conferring with the several county societies, could arrange the time of their annual exhibitions in such a manner, that they would all precede the exhibition of the State Society, at the same time securing the exchange of delegates, and preventing the evil arising from holding the meeting of adjacent societies on the same week.

Cannot the county societies meet during the last week of September, or the first week of October, so that the State Society could hold its exhibition on or before the middle of October?

Careful observers will testify, that the weather at that period is usually milder and less disturbed by storms and winds, than it is near the last of September; and certainly, the interests of a large exhibition, and of a great gathering of people, should be regarded; the sacrifices and inconveniences, if any, should be submitted to by the county societies.

Suppose this plan to be adopted, then let the State exhibition be made up mainly from contributions from the county societies;

let each society be requested to forward their *premium* articles, and all of them possible, (not excluding others, however,) perhaps at the expense of the society and under the care of an agent; and let the contributions from each society be exhibited in *departments by themselves*, affording thus the best opportunity for comparisons, and encouraging competition.

In this way, we have the smaller collections of town and county societies finally centering in the State exhibition, affording to the citizen and the stranger a full opportunity of seeing what the industry of the entire State has accomplished for the year.

The plan thus briefly proposed, is not suggested in order to censure existing arrangements, but because it is thought to be an improvement; neither is it merely an experiment, as it has been successfully tried in at least one State.

Objections, without doubt, can be raised, but it is believed that time and experience would soon overcome them; and even if the whole plan cannot at once be adopted, it is respectfully suggested, that it mght not be unprofitable to take the first step in this direction."

Whereupon it was

Voted, That the Secretary be requested to correspond with the several agricultural societies in the State, and ascertain if they would delegate to the Board the power to fix the times of holding their annual exhibitions.

On motion of Mr. Chamberlain, the following preamble and resolution were adopted:

Whereas, this Board acting in obedience to the laws of the State as expressed in the organic act, would duly feel the importance of the duties imposed on us to investigate all such subjects relating to agriculture, horticulture and the arts connected therewith in this State, " and to act for 'the promotion of 'agricultural education,' and make 'such recommendations and suggestions as the interest of agriculture may seem to require,' " and,

Whereas, reliable conclusions in respect to such comprehensive subjects cannot be obtained without deliberation and proper investigation, and,

Whereas, the results of the labor done at our brief sessions, cannot be largely profitable and creditable to us, nor sufficiently useful and instructive to others, when we assemble without preparation, therefore, *Resolved,* That when we adjourn, we carry home with us an abiding sense of the importance attached to our position, and a determination to apply whatever capacity we may possess to a preparation for the more efficient discharge of our duties at our next session.

Resolved, That we individually pledge ourselves to visit agricultural exhibitions, so far as we may be able, and report at our next session.

Resolved, That we will make some experiment in agriculture or horticulture, and report at our next meeting.

On motion of Mr. Cargill, the business committee were instructed to report topics for investigation during the interim, and the following were accordingly selected and assigned:

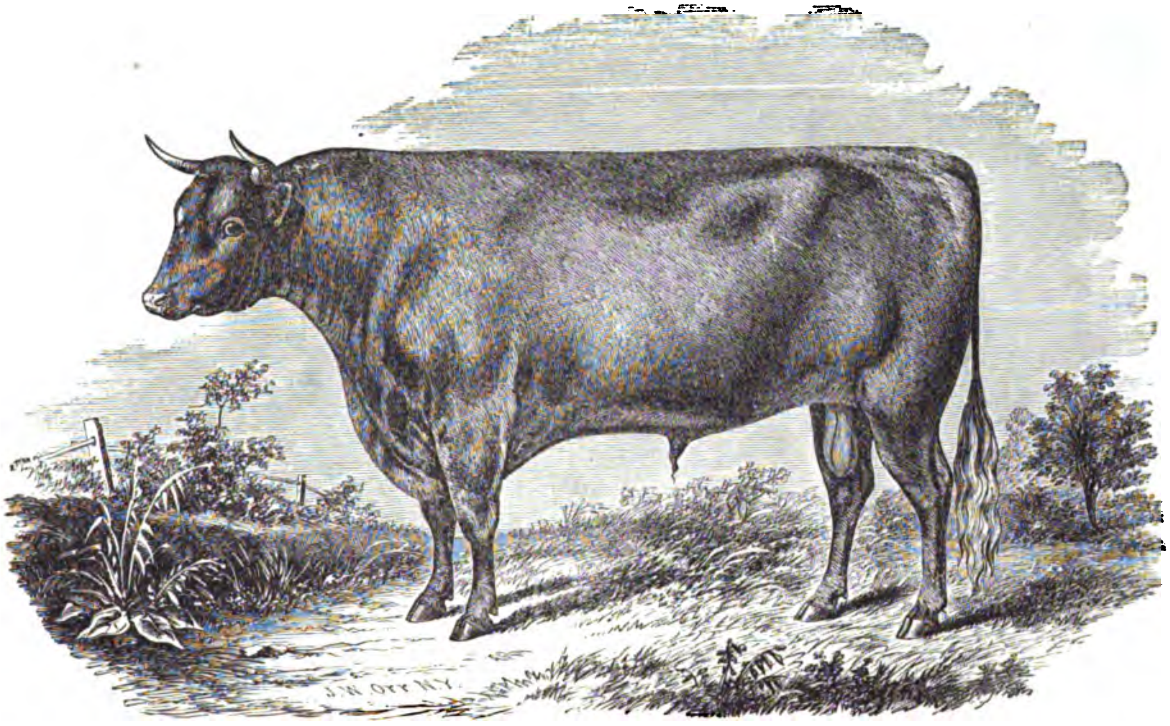
Diseases of vegetation, J. C. WESTON.
Fruit culture, JNO. CURRIER.
Cranberry culture, DAVID CARGILL.
Turnip culture, Ellis Fish.
Beet culture, JOEL BEAN.
Potato culture, GEO. A. ROGERS.
Indian corn culture, J. S. CHANDLER.
Carrot culture, C. CHAMBERLAIN.
Breeds and management of sheep, F. JEWETT.
Calcareous manures, E. L. HAMMOND.
Farm accounts, S. F. PERLEY.
Feeding of farm stock, R. MARTIN.
Rotation of crops, HUGH PORTER.

On motion of Mr. Chamberlain, the following preamble and resolution were adopted:

Whereas, It is the province of this Board to prescribe the duties of the Secretary; therefore,

Resolved, That in addition to those prescribed by statute, the Secretary be instructed to acquaint himself so far as practicable by personal inspection, with the capabilities of the soils of Maine and the general husbandry of the State; and that he invite correspondence and exchange of documents with kindred associations, for the promotion of agriculture in other States and countries; and also that during the current year he shall endeavor to ascertain some feasible method by which the *offal* of *fish,* so abundant in some sections of our sea-coast, may be converted into an inoffensive, portable and efficient manure, and that he invite attention to the manufacture of the same.

Adjourned without day.



DEVON BULL, CAYUGA. 602.

Bred by Edward G. Faile, West Farms, Westchester Co., N. Y. Cayuga took the first premium as a calf at the New York State Fair in 1858, the first as a yearling at the American Institute Fair 1859, and at the New York State Fair 1859, and the first at the Westchester Co. Agricultural Fair, 1861.

Marine Manures. Having been instructed by the Board of Agriculture at its late session (see page 41) to endeavor to ascertain, during the current year, " some feasible method by which the offal of fish, so abundant in some sections of our sea-coast, may be converted into an inoffensive, portable and efficient manure," I have directed inquiries to this point. This subject naturally suggested the broader one of *marine manures* generally, and to its investigation I have chiefly devoted my time during the past season, traversing the whole extent of our sea-coast, from Kittery to Eastport. Some thought had been previously bestowed upon the subject and occasional allusions made to it in previous reports, but as the investigation of the present year progressed, its importance and magnitude impressed themselves upon me more and more every day. Our resources here are absolutely incalculable. Our coast line, including islands, bays, coves and all indentations, cannot be much less than a thousand miles in extent, and may be considerably more. It is my earnest conviction that the coasts of Maine, when called upon, are capable of yielding fertilizing materials sufficient to render productive like a garden, every acre of cultivated soil in the State. Much of this, it is true, is too heavy and bulky to be transported cheaply a long distance; but I believe that another portion, by an inexpensive process, may be so concentrated as to be profitably taken to any required locality in the interior of the State.

The ocean is a vast magazine of wealth for the farmer. During thousands of years the finer particles of soil, and what is of more importance still, its soluble portions, the very part upon which its fertility chiefly depends, have been carried thither and swallowed up in its embrace. Every stream, every rain drop even, which has not been arrested by the soil until evaporated again into the air, has furnished its contribution. Every city and town on the banks of a river have consumed human food in large quantities and yielding trifling returns to the fields which produced it, have given the great bulk of their rejections to the ocean, and there it is still, some of it in mud on the flats, some in muscle bed, some in marine plants, some in fish that swim, some in shell fish by the shores, and some in other forms. Except a trifling amount of fish, rockweed, salt, muscle bed and guano, no reclamations have been made upon this great storehouse. Let the abundance of the seas be converted to the uses of the husbandman. New methods of employment may thus be opened for thousands of our industrious citizens, cheap manure be supplied to the farmer, food for the people and wealth to the State.

Our first inquiries relate to fish.

1. Can this be had in large quantities and at small cost?

2. What is its value as a manure?

3. Can it be cheaply prepared so as to furnish an inoffensive, portable, efficient and profitable manure for the use of farmers away from the sea-side? and, lastly, regarding the preferable method of using it.

To the first inquiry whether a sufficient supply can be cheaply obtained, it may be sufficient to say, that, throwing wholly out of account all the offal from the fish cured along our shores and islands, amounting to thousands of tons annually,* and also all the inedible or refuse fish which are taken while seeking better ones, all the dogfishes, lumpfishes, skates, sculpins and many others, and looking only to the migratory fishes which visit our shores, we have in these alone an almost exhaustless resource. Of this class the *Cuphea Menhaden* of the naturalists and commonly known as pogies, hard-heads or menhaden, is the most common and abundant. These annually visit our whole coast in immense numbers, remaining from July to October. At various points the business of catching them for the oil they yield has gradually grown to become of considerable importance. In many towns (probably more in Hancock county than any other) thousands of barrels of fish oil are thus obtained each year. Every barrel of this represents from eight to twelve barrels of raw fish, the yield of oil varying according to their fatness from 8 to 12 per cent. For a long time no attention was given to the residuum left after expressing the oil, that is the cake, pumice, or as commonly called, the *chum*, and which contains nearly the whole fertilizing portions of the fish. It was thrown back into the sea. Gradually it came into use; at first in a very rude way, but by degrees with more judgment and care. At the present time much is saved and used, and has effected a wonderful increase in the productiveness of many naturally poor farms. Upon many farms the increase of the crops, especially that of hay, has been many fold. But a great deal, and more especially on the islands visited during the summer months for the purpose of making oil, is still lost—no use whatever being made of it.

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* Lieut. Gautier states that the produce of the Newfoundland codfishery amounts to 700,000 quintals annually; also that 400 tons of fresh cod are required to yield 120 tons of dried fish for exportation. This statement affords some data by which to judge what a resource may be found in *offal* alone.

Besides the pogies thus used, thousands of barrels of bait are prepared from the same fish by taking a sliver of flesh from either side, which is salted and the remainder thrown overboard. The offal from those thus used, would if saved, be capable of yielding a great amount of manure.

The fact that the visits of the menhaden are in greatly unequal numbers in different years in the same locality, and that at different times in the same season and locality, they are sometimes plentiful beyond the means of disposing of them, and again scarce, is a drawback upon the uniformity of the supply, and consequently upon the profits of the business, but it has not proved serious enough to prevent the steady increase of the numbers taken from year to year, as attention has been drawn to the manufacture of fish oil by this method.

The Herring is another migratory fish which is found in abundance on the shores of the eastern part of the State. Large quantities of these are pickled, smoked and dried for consumption and sale. The numbers in which they annually return to the same localities are more uniform than with the menhaden. Mr. Treat of Eastport, of whose operations I shall have occasion by and by to speak more at length, formerly cured great numbers of this fish, but of late he finds it more profitable to convert them into manure. Last year he manufactured one hundred and fifty tons of "fish guano," by far the larger portion of which was made from the herring, employing for the purpose not less than six hundred tons of raw fish, which were taken in the weirs about the island on which he resides.

I am not aware of any data by which the amount of fish thus taken, or which might be taken, can be ascertained with any degree of precision, but that the supply is ample, if not absolutely inexhaustible, seems to be established beyond question.*

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* Prof. Cook of New Jersey, in his Geological Report says "The fish, particularly the mossbunkers, which abound near our shore, have been much used as a manure.

Our next inquiry regards the value of fish as a fertilizer.

The chemical composition of fish is very similar to that of flesh, and its action as a manure corresponds closely to that of the bodies of other animals. Johnston says "the bones of fish are similar in composition to those of terrestrial animals and their muscular parts are nearly identical in elementary constitution with the lean part of beef and the clot of blood. As fertilizing agents, therefore, the parts of fishes will act nearly in the same way as the blood and bodies of land animals." The fertilizing power of animal substances depends chiefly on the nitrogenous substances of the flesh and other soft parts, (capable of yielding ammonia) and the phosphates contained in the bones. Next in importance to phosphoric acid is potash.

Perhaps we can arrive at a more satisfactory judgment of the value of fish as a fertilizer by comparing it with some other substance of acknowledged efficacy, say, for instance, farm yard manure, than by an abstract statement of its composition. Farm yard manure, it is true, varies greatly in its fertilizing properties according to the character of the food consumed by the animals yielding it, but for this purpose we will assume that it consists of the solid excrements of horses and cattle fed on good hay and in a recent state. Such manure contains about the same proportion of water as fish in a natural state, say from 70 to 80 per cent. It also contains only about one-half of one per cent. of nitrogen, while fish contains about two and one-half per cent. the latter being in respect of this most important constituent about five times more valuable than the former. Fish in the natural state contains upwards of two per cent. of inorganic matter, of which nearly one-half is phosphoric acid, and so in respect of this next important

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Applied in the raw state, they are powerful fertilizers, and contain ammonia and phosphoric acid sufficient to make of it a valuable concentrated manure. The amount of material for such manure which could be obtained upon our shores, has not been accurately estimated, but it is *enormous*. A friend who has been at some pains in making inquiries upon the subject, estimates the amount which could be obtained at a single point on the shore, during one season, at one hundred thousand barrels. Sixty waggon loads were taken at a single haul on the shore of Raritan Bay the last summer."

According to the Encyclopedia Brittanica, the quantity of *white herrings* caught and dressed in Scotland and the Isle of Man, amounted in 1853, to 908,800 barrels. In England and Scotland together, in 1849, 1,151,979 barrels were disposed of as food.

constituent is three or four times as valuable as farm yard manure, while in potash, which comprises from seventeen to twenty per cent. of the inorganic constituents above alluded to, it is peculiarly rich.

The oil of fish (corresponding to the fat of land animals) although by many esteemed to be an important part, should be deemed such only for its commercial value when separated. Its value as a fertilizer (unless first made into soap by the use of some alkali as potash or soda,) is so trifling that it may be thrown wholly out of our estimate. Prof. Way says "so far as we know oil is of no value as a manure, or at all events of a value far beneath that which it holds as an article of commerce." Putting the oil, therefore, aside from our calculation, it is safe to conclude that fish, in a recent state, is at least four times as powerful in fertilizing properties as farm yard dung.*

A very striking characteristic of fish which analysis has brought to view, and which is amply sufficient to convince any enlightened practical man of its utility in farm practice, is the fact that in chemical composition fish closely resembles some of our most valuable crops. Prof. J. Thomas Way in a communication to the Journal of the Royal Agricultural Society, after giving the detailed results of analyses of sprats, (a fish taken at certain seasons in large quantities on some parts of the coast of England) goes on to say "as a matter of practical importance, I would draw attention to the similarity of composition between some of our cultivated crops and that of sprats. Wheat, for instance, contains about two per cent. of nitrogen; so does this fish. One hundred pounds of wheat require one and three-quarters pound of ash, of which about one-half is phosphoric acid, and about one-third is potash. One hundred pounds of sprats contain two pounds of ash, of which about two-fifths is phosphoric acid and one-fifth potash. What manure should be more fit to produce a bushel of wheat than half a cwt. of sprats? Indeed there is nothing surprising in this resemblance. The composition of sprats would probably be found nearly identical with that of any *entire animal* examined in the same way.

We know that wheat contains everything that is necessary to support life and to increase the animal frame; in other words, it is identical or nearly identical in composition with the body which it nourishes. Sprats, then, may be taken as the type of animal—wheat as that of vegetable life, and there can be no doubt of their mutual convertibility when placed in the proper circumstances.

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* Consequently if fish by drying can be reduced to one-fourth its original weight, the dry substance or fish guano so made, may be considered worth sixteen times its weight of common farm yard manure.

I have dwelt upon this point in order to show how very valuable a source of manure, and consequently of food, we have in the waters which surround our shores if we could work out the problem as one of economy. Practically we do so at this day by bringing guano, which is *digested fish*, from far distant parts."

"Thus by induction drawn from the analysis of an insignificant fish—a sprat, we arrive at a knowledge of the grand truth which science in a hundred other ways has pointed out to us, and our daily farm practice exhibits, that vegetable and animal growth is not a creation, but a transformation and transposition of matter—a continual readjustment of elements which are as continually being transferred from the animal to the vegetable world; and that the materials for future structures, vegetable and animal, are to be found in similar structures that have already served their purpose. One crop furnishes materials for another if applied directly to the soil. In farm practice however, one portion goes to grow an animal, the remainder is restored to the soil. Animals in their turn, sustain human strength and furnish elements of future fertility, When, however, as in the case of fish, we apply the *whole* frame to the soil, we obtain as we have seen, a manure rich in all the chief elements that vegetation has need of."

It is not true in all cases that the chemical composition of a substance affords a certain criterion of its fertilizing power, for reasons which may not be here fully detailed—often because the combinations or conditions in which they exist are such that its elements are not available to the plant, a notable instance of which is found in the case of coprolites or fossil and mineral phosphate of lime, which needs special preparation before it yields up the phosphoric acid contained in it; but nothing of this sort is the case with regard to fish, this on the contrary, gives up all its fertilizing elements with great readiness. The use of fish as a manure is of high antiquity. The earliest English writers speak in terms of high praise of refuse of the pilchard fisheries and the "carcasses and garbage of other fish which the coast men bestow upon their thin, lean and hungry grounds." Its employment has been common for a long time on the coasts of England, France and other European countries, in Newfoundland,* and on the shores of New England, but usually only near the shores and in an occasional and unscientific manner. Without dwelling in detail on the results of experience, it may be sufficient to say that its efficacy is universally acknowledged, and the objections occasionally made of ill effects would apply with equal force to any other manure of equal power when as carelessly or injudiciously used. Instances were not infrequent in our coast towns when the pogy "chum" first came in to use, of injurious effects. Frequently it was used in too large quantities. One farmer told me of his first experience with it as follows: Hearing how efficacious and cheap it was he procured several cart loads and composted it with three times its quantity of earth. The next spring, seeing the heap look little different from soil alone, and with little faith in its efficacy, he applied a shovel full to each hill of corn. It came up well, grew well for a while, looked very green and vigorous, but soon began to grow pale and sickly, and presently it all perished and he lost his crop. I saw this same field, now in grass, some years after, with no additional manure and bearing an immense burden. I was also told of cases where its free application in a raw state as top dressing to grass lands had imparted a fishy flavor to the hay, so that cattle refused to eat it, but whenever it had been judiciously used I heard but one testimony.

The chief obstacles to an extended use of fish in a recent state, as manure are obvious at a glance. The chief are these. It can be had in abundance only near the sea-coast. It is quickly perishable and soon becomes very offensive; to which may be added the fact that fish are not found in abundance even by the coast, at the usual time of applying manures to the land, in early spring.

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* Gov. Hamilton of Newfoundland, in a communication to the Home Government on the importance of converting the refuse of the codfishery into a portable manure, says:

"In this Island the manure universally applied to the soil is fish, consisting of the superabundant herring and caplins in the process of decomposition, and generally without any earthy admixture; and the heads, bones and entrails of codfish after having been decomposed and formed into a compost with clay or bog earth.

This manure, I learn, has, on trial comparison, been found more fertilizing than guano; and when applied to the thin, gravelly, unpromising soil in the neighborhood of this town, yield crops of grass and potatoes, which, in vigor of growth and productiveness, cannot be surpassed elsewhere. It is no less powerful when applied to oats, which, however, owing to the shortness of the season and the consequent uncertainty of the ripening of the grain, are but partially cultivated."

The next inquiry and a very important one is, can these obstacles be overcome? Can fish be cheaply converted into a concentrated and inoffensive manure?

For some years past attention has been directed to this point. A great many methods have been proposed and not a few have been patented. Some have proved successful, while others have failed. The failures seem to be chiefly due to the use of too complicated and too costly processes and the use of expensive machinery. Prof. S. W. Johnson of Yale College, in a communication to the Country Gentleman in July, 1857, gives credit for the first successful attempt to an American. He says:

"From the information I have been able to gather, it appears that the first attempt to manufacture a portable manure from fish, was made at New Haven, Conn., as early as 1849, by Mr. Lewis. The white fish, *Cluphea menhaden*, was employed, and after a good deal of experimenting, a quantity of the manure was sent into market, but from causes unknown to me, the enterprise was discontinued. Analyses made in this laboratory at the time, under the direction of Prof. Norton, represent the amount of nitrogen in the product as high as 10.23 per cent., equal to 12.42 per cent. ammonia.

The second effort was made by De Molon, a Frenchman, in 1851 or 1852.

Afterward, Pettit and Green, in England, engaged in the manufacture, and within the last two years we hear of numerous successful efforts in the same direction."

The patented process of De Molon is understood to be now in operation at Southold on Long Island, New York, by the "Oceanic Oil and Guano Company." In a pamphlet put forth by this Company, it is stated as follows:—"The raw fish in quantities of one and two-thirds tons (or about 5000 fish) are placed in the inner chamber of a revolving double cylinder, the vacuum between the inner and outer cylinder being heated by steam at about 80 pounds pressure. Before letting in the steam the cylinder must be put in motion so that each fish, as the cylinder revolves, is constantly changing its position. The cooking at this pressure of steam requires but ten minutes; during which time a uniform temperature is maintained by means of one head of the inner cylinder being perforated so as to allow the escape of the steam generated from the water contained in the fish, which prevents the dissolution of the gelative and all the soluble parts, and they are therefore retained in the fish. When the heat in the inner cylinder has arrived at the temperature to produce steam from the fish, it escapes through the perforated head and thus enables the fish to receive a temperature just sufficient to open the cellular tissues and give an easy and speedy egress to the oil.

After the fish are thus steamed, they are put into strong bags, prepared in size to fit the top of the press-head, in layers of eight inches of thickness; between each layer or bag is placed a strong iron plate. In this manner the press is filled, when they are subjected for about five minutes to a powerful hydraulic pressure. After the oil has ceased to run, the remains are then put through a strong picker which reduces the cakes to small particles for the drying process." It is then dried by heated air or upon platforms exposed to the sun.

The same pamphlet gives the following as the results of working up forty tons of various kinds of fish by this process at Lowestoft, England, in 1856:

40 tons	summer herrings	produce	9 tons	guano	and	1092 galls.	oil.
40 "	autumn herrings	"	9 "	"	"	924	"
40 "	dogfish	"	9 "	"	"	840	"
40 "	sprats	"	9 "	"	"	840	"

The value of the products there are said to be

9 tons guano at $45 per ton, - - -	405 00	
840 gallons oil at 67⅓ cts. per gallon, - -	565 60	
		970 60

and the daily expenses

40 tons fish at $5.50 per ton, - - - - - -	220 00
Labor, &c., - - - - - - - - - -	25 00
1 ton coal, - - - - - - - - - -	2 50
180 bags for the 9 tons guano at 20 cts., - - - - -	36 00
Casks for 840 gallons oil at 5 cts. per gall., - - - -	42 00
Interest, insurance, freight, &c.. - - - - - -	69 50
	395 00

Profit, $575.60.

And it is claimed that the above results have been nearly if not fully equalled at the Southold Oil and Guano Works, by Wm. J. Brundred, in 1857.

De Molon, in company with his brother, according to Payen, has an establishment on the coast of Newfoundland, at Kerpon, near the eastern entrance of the Strait of Belle Isle, in a harbor greatly resorted to by vessels engaged in the codfishery. This manufactory is able to produce 8,000 or 10,000 tons of manure annually.*

According to the *Chemie Industrielle,* De Molon erected an establishment at Concarneau in the department of Finisterre, for the manufacture of guano from the refuse of the sardine fishery, and which in 1854 employed six men and ten boys, working up daily eighteen or twenty tons of refuse and making four or five tons of the powdered manure. According to the report of several analyses of this product, it contained 80 per cent. of organic matters, corresponding to 12 per cent. of nitrogen or 14½ per cent. of ammonia and about 14 per cent. of phosphates of lime and magnesia.

The peculiar feature of Pettit's patent process is the use of sulphuric acid, which is added to the fresh fish in order to change its consistence. It is afterwards pressed and dried by a current of hot air.

In an article published in the *Practical Mechanics' Journal,* the cost of preparing fifty tons of fish manure by this process, is stated as follows:

100 tons of fish at £2 per ton, - - - - - -	£200.
Sulphuric acid, - - - - - - - - - -	17.10
Labor, - - - - - - - - - - - - - -	25.
	£242.10

or about $24 per ton—not including interest on capital invested or wear and tear, &c. There is doubtless some error here, as 100 tons of fresh fish cannot be expected to produce more than 25 tons of concentrated manure, and on the other hand there is a product in oil to reduce its cost; while the price at which the raw material is placed, is at least three or four tons greater than rules on the coast of Maine.†

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* Payen estimates the total yearly produce of the codfisheries of the North American coast to be equal to 1,500,000 tons of fresh fish, of which one-half is refuse and is left to decay on the shore or thrown into the sea, while it is capable of yielding at least 150,000 tons of concentrated manure. *T. S. Hunt in Report of Geology of Canada.*

† The highest price which I have heard of as being asked for pogy chum on our coasts is 25 cents per barrel of 150 pounds. This was at Brooklin in Hancock county, in which vicinity it has been used more extensively than any where else in the State. When we remember that this in being pressed has already parted with at least an equal weight of water or oil and water together, we see that the current price in Maine for material *to make manure of* is equivalent only to $1.67 per ton for raw fish.

Prof. Johnson (as above quoted) also says:

"A company has recently been formed at Christiana, in Norway, with the object of making fish manure. Samples of their first products have been analyzed by Stockhardt, (*Chemischer Ackersmann*, 1856, No. 2,) and contained about 10 per cent. of nitrogen, and 8 per cent. of phosphates of lime and magnesia.

On the coast of the North Sea, in Oldenburg, an excellent manure is made from a kind of small sea-crab that is caught there in large quantities. The crabs are simply dried and ground. According to an analysis in Liebig's *Annalen der Chemie*, March, 1856, this manure, called Granat-Guano, from the name of the crab, contains 11.23 per cent. nitrogen, and 5.23 per cent. phosphates of lime and magnesia."

Mr. Hunt, in Geological Survey of Canada, under date of March, 1858, says:—"Mr. Duncan Bruce of Gaspe, has lately been endeavoring to introduce the manufacture of fish manure into Canada; but he conceived the idea of combining the fish offal with a large amount of calcined shale, under the impression that the manure thus prepared will have the effect of driving away insects from the plants to which it is applied. He employs a black bitumenous shale from Port Daniel, and distilling this at a red heat passes the disengaged vapors into a vat containing the fish, which by a gentle and continued heat have been reduced to a pulpy mass. The calcined shale is then ground to powder and mingled with the fish and the whole dried. Experiments made with this manure appear to have given satisfactory results and is said to have had the effect of driving away insects when applied to the growing crops, a result which may be due to the small amount of bituminous matter in the products of the distillation of the shale, rather than to the admixture of the calcined residue. Coal tar is known to be an efficient agent for the destruction of insects, and in a recent number of the Journal, *Le Cosmos*, it is stated that simply painting the wood work of the inside of green houses with coal tar, has the effect of expelling from them all noxious insects." Analyses of this manure by Mr. Hunt showed it to contain about 3 per cent. of ammonia and something more than 3 per cent. of phosphoric acid; and so of less than half the manurial value of a well made article from pure fish alone.

Prof. Cook, State Geologist of New Jersey, in his Report for 1856, says that "an establishment for making a concentrated manure from king crabs or horse feet, had been erected at Goshen, in Cape May county, by Messrs. Ingham & Beesley. Several hundred tons of this substance were made last year and sold under the name of *cancerine*. It is a powerful fertilizer, and in its composition, as well as in its effects, has considerable resemblance to guano." The average per centages of ammonia and phosphoric acid in cancerine as shown by three analyses by Prof. Cook was 9.92 per cent. of ammonia and 4.05 per cent. of phosphoric acid—and he estimates its value at $31 per ton, and farther says "the results of trials with it, have fully sustained its value as determined by the analyses."

From an article in the August number of the Farmers' Magazine (London) for 1859, by Samuel Osler of Great Yarmouth, and who claims to have discovered a method preferable to that of De Molon or Pettit, a few paragraphs are quoted. "The enormous consumption of guano, its high price and extensive adulteration have led to the desire for an auxiliary or substitute. The most obvious source is the fishery. None but a fisherman can tell the take of a trawler—the quantity of fish is illimitable. It only depends on energy and skill to take any quantity that may be required. We have around our seaboard an unfailing supply, and if, instead of trusting to the agency of birds we were to convert the fish which swarm our coasts into manure, it would materially aid our fisheries and be a valuable boon to agriculture. What we require is a cheap, simple and effectual mode of separating the parts which are needless for manure, the water, gelatine and oil—the two latter sufficiently pure to be commercially valuable, and leaving the fibre, bones and scales in a state fit for keeping and for use. It has been ascertained by experiment and confirmed by actual working that the refuse and waste fish may be thus converted and the gelatine and oil collected by a process which I have discovered. The machinery and the process are simple, inexpensive and effectual. The principle of the manufacture is founded upon the fact that when fish or flesh is subjected to a long continued and moderate heat, the fluids separate, dissolve the gelatine and leave the fibrous and bony solids. This is easily shown by putting meat or fish into a Florence flask and setting it in boiling water, corking the flask when fully heated; the fluids will gradually separate, while the flesh will after a time be left a dry and insipid residuum." Mr. Osler gives the results of several analyses by Profs. Way and Voelcker and Dr. Stockhardt, by an average of which it appears to contain about 12 per cent. ammonia and 7 per cent. of phosphates.

Until within a few months I was not aware that any attempts had been made, in our State, to manufacture a portable manure from fish, but I have recently learned of several. In Boston I found an article for sale under the name of Fish Guano, which upon inquiry was ascertained to have been made by a Mr. Fowler at Lubec. I learned subsequently that he had manufactured a quantity two or three years previously, but that either from not finding a ready sale, or from other causes, had discontinued its manufacture. It is understood to have been made by drying the fish after pressure, when it was ground and a portion of gypsum mixed with it. As offered for sale it was a grayish powder in which portions of bone could be distinguished.

Learning that a somewhat similar article had been sold and used in some of the Penobscot towns from Mr. C. G. Alden of Camden, I called upon him and found that he had made last year, for the first time, about a hundred barrels at Long Island, in Bluehill Bay, which he sold readily at $1.50 per barrel of about 150 pounds, and learned that it gave entire satisfaction. It was prepared from pogy chum by simply drying it in the sun, and when packed he added a peck of gypsum to each barrel. Some barrels were examined which had just been made, (August, 1861,) and the article appeared to be in a good state of preservation, except that it was slightly moist and gave off free ammonia. Mr. Alden intimated that the lack of sufficient capital alone prevented his entering into its manufacture upon a much more extended scale. He hoped however to prepare five hundred barrels or more the present season.

At Eastport, I found fish guano manufactured upon a larger scale. Messrs. U. S. Treat & Son (well known for their enterprise, perseverance and success in the artificial propagation of fish,) after preliminary trials for some years past, prepared about one hundred and fifty tons during the season of 1860, nearly the whole of which was shipped to Connecticut. He makes it under a patent, held or claimed by the Quinnipiac Co. of Connecticut.

It is manufactured almost entirely from herrings, of which they formerly cured a large amount, but now find it more profitable to make into guano. They are caught in weirs (about Treat's Island on which they reside,) and are thence taken to a railway running into the water and dipped into a car drawn up by a windlass.

When the car comes to be opposite one of a tier of tanks near the track, a gate or door in the car is opened and the fish slide in; salt is added in the proportion of one bushel to each hogshead (of four barrels) of fish. After pickling for about twenty-four hours they are moderately heated in open kettles, when they are pressed to obtain the oil, of which they yield about 8 per cent. and to express as much of the water as possible; after which the cake or chum is broken up, spread on a platform of boards and dried in the sun. It is subsequently ground and packed in bags of two bushels each and which contain eighty pounds—twenty-five bags or about fifty bushels to the ton of 2,000 pounds. He sells it for $15 per ton; and the cost of the bags, delivering or shipping are extra charges.*

The platform in use last year for drying, is about eighty by one hundred and twenty feet square, slightly inclined to the sun, with a store house on the lower side. Another was in process of erection, when I was there, as also another railway and other conveniences for extending their operations.

The patent held or claimed by the Quinnipiac Company is understood to be "for drying by solar heat upon an elevated platform." If a patent be granted for this, why not for drying salted fish upon an elevated flake—or for drying clothes on an elevated line, by solar heat?

From various sources, I learn that the fish guano prepared by this method, gives high satisfaction.

Prof. S. W. Johnson, of Yale College, Chemist to the Connecticut State Agricultural Society, informs me that the article prepared by the Quinnipiac Company is the most popular fertilizer sold in that State.

To sum up in a word the result of my investigations and experiments regarding the manufacture of a portable, inoffensive and efficient manure from fish or fish offal, I may say that I deem the same practicable—that no costly machinery or complicated processes are required—that all which is necessary is first to cook the fish sufficiently to coagulate the albumen contained in it, then to express as much of the oil and water as may be, and to dry the remainder as quickly and thoroughly as possible. A pickling of the fish first with salt would probably facilitate the operation.

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* The price here stated is as given me by Mr. Treat in August, 1861. As this goes into the printer's hands I understand the price has been advanced to $30 per ton (*including* bags, shipping, &c.)

It is confidently hoped that the waste of such enormous quantities of fertilizing material, as have hitherto been thrown away, will not much longer go on, but that they be converted to use, feed our hungry fields and fill our barns with plenty.

SEA-WEED. This name is popularly applied to several marine plants quite distinct from each other. In some parts of the State I find this term has a limited meaning, being confined to what is elsewhere known as eel grass, the *Zostera marina* of botanists, a long, narrow leaved, grass-like (flowering) plant growing in abundance in bays along our coasts and often thrown ashore in large quantities; while in the same sections the *Fuci*, or what are commonly known as sea-weeds, are distinctively known as rock-weed, but usually both the *Zostera* and several species of *Fuci*, together with the *Laminaria digitata*, (sometimes called kelp,) are indiscriminately known as sea-weed. It may be well to bear in mind this distinction in popular nomenclature as accounting in some measure for a difference in opinion as to the value of sea-weed for manure, the Zostera or eel grass being much inferior to any of the other plants which pass by the same general name.

Of the *Fuci* there are two which grow in abundance on the rocks of all our coast from Kittery to Eastport. These are *Fucus nodosus* and *Fucus vesiculosus*. They are readily distinguished from each other, *F. nodosus* having a broader leaf, covered with rough nodes or bunches usually about half an inch in diameter, filled with a mucilaginous liquid of more or less consistence at different periods.

Fucus vesiculosus is of a longer and more slender growth. It is also supplied with nodes or vesicles, but they are fewer, smooth, egg shaped and empty. The proportions in which these are found vary greatly in different sections. The latter is by far the more abundant in the eastern part of the State, while *F. nodosus* is much the more plentiful one in the western part. They chiefly inhabit shallow water, and being left uncovered by the ebb-tide may be collected in large quantities at all seasons. The plant sometimes, though improperly, called kelp, and by botanists known as *Laminaria digitata*, has a very long round stem and long leaf, both together sometimes as much as 30 or 40 feet in length, and grows only in deep water. It may occasionally be collected at low water from the rocks, but is generally obtained after storms which tear it off and throw it upon the shore.

Many other marine plants are found upon our coast, but the three last named far exceed all the others in abundance and form the great bulk of what passes under the name of sea-weed and is collected for fertilizing purposes, and it is chiefly to these that my remarks will be directed.*

Sea-weed differs widely from any land plants, and far exceeds any of the latter in manurial value. At various times analyses of several species have been made, but chiefly with reference to ascertain their comparative value for the production of kelp, by which is understood the partially melted ashes obtained by their combustion, and which was formerly the only source from which the soda of commerce was obtained. It is not until recently that scientific investigations have been made into their constituents with reference to the fertilizing properties of the unburned plants.

In 1856, Prof. Anderson contributed a valuable paper to the Transactions of the Highland and Agricultural Society of Scotland, and some of the results of his analyses are given below.

The first noticeable peculiarity of sea-weeds, is that they contain a very large proportion of water, varying from 70 to 88 per cent., half or more of which they readily part with on drying, the remainder being held with considerable tenacity. Another is that they contain a much larger proportion of mineral constituents; 100 parts after being dried at the temperature of boiling water, yield from 14 to 20 per cent. of ash, the amount varying with the species used, its maturity, stage of growth and the locality where it grew. No cultivated plants yield so much, and few more than half as much. This ash is rich in alkaline salts, including phosphate of lime. In fact the ash of sea-weeds contains all the substances taken from the soil by our usually cultivated crops, and so it may be considered a general, rather than a special fetilizer.

The analyses of Prof. Anderson above referred to showed the following results:

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* *Fucus saccharinus*, commonly known as "Dulce," grows in considerable quantities on some parts of our coast, and to a limited extent is collected for sale. Sheep are very fond of it, and it is said that to it is owing much of the peculiar excellence of Island mutton.

Fucus nodosus.

Water,	74.31
Nitrogenous compounds,*	1.76
Ash,	4.89
Fibre,	19.04
	100.

The ash of the same yielded the following:

Per oxide of iron,	0.26
Lime,	9.60
Magnesia,	6.65
Potash,	20.03
Iodide of potassium,†	0.44
Sulphuret of sodium,	3.66
Soda,	4.58
Chloride of sodium (common salt,)	24.33
Phosphoric acid,	1.71
Sulphuric acid,	21.97
Carbonic acid,	6.39
Silica,	0.38
	100.

Fucus Vesiculosus.

Water,	70.57
Nitrogenous compounds,‡	2.01
Ash,	5.37
Fibre,	22.05
	100.

The ash upon farther examination yielded as follows:

Per oxide of iron,	0.35
Lime,	8.92
Magnesia,	5.83
Potash,	20.75
Soda,	6.09
Iodide of Potassium,	0.23
Chloride of sodium,	24.81
Phosphoric acid,	2.14

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* Containing nitrogen, .28. † Containing iodine, .33. ‡ Containing nitrogen, .32.

Sulphuric acid,	28.01
Carbonic acid,	2.20
Silicic acid,	0.67
	100.

Dr. Anderson analyzed several specimens of Laminaria, which showed results not much dissimilar from the above; the chief difference being that a very large specimen yielded several times as much of protein compounds as did a smaller one, thus indicating what would otherwise seem highly probable, to wit, that full grown plants are richer as manure than those which have not come to maturity.

A specimen of mixed sea-weed which had undergone partial fermentation gave the following results:

Water,	80.44
Protein compounds,	2.85
Fibre,	6.40
Ash,	10.31
	100.
Containing nitrogen,	0.45.

The ash of the above yielded:

Per oxide of iron,	2.35
Lime,	18.15
Magnesia,	6.48
Potash,	12.77
Chloride of potassium,	9.10
Iodide of potassium,	1.68
Chloride of sodium,	22.08
Phosphoric acid,	4.59
Sulphuric acid,	6.22
Carbonic acid,	13.58
Silicic acid,	3.
	100.

Dr. Anderson then remarks. "In estimating the value of sea weed manure it may be most correctly compared with farmyard manure, for both substances are of vegetable origin; and though the latter contains also abundance of animal excretions, yet even they are indirectly derived from the food of the farm animals.

Hence it follows that sea-weeds like farmyard manure supply to the soil all the constituents of land plants, and that in proportions pretty nearly the same as those which are to be cultivated upon it. In contrasting it with the published analyses of farmyard manure a very remarkable similarity is found to exist in the composition of the two. Farmyard manure is found to contain in round numbers, 80 per cent. of water and 0.4 per cent. of nitrogen. The latter, which by some writers has been considered to be above the average of ordinary farmyard manure, appears therefore to show that the sea weeds, weight for weight, somewhat surpass that substance. Much of course will depend upon the proportion of the different species of weeds contained in the mass applied, for a reference to the analyses of the *Fucus Vesiculosus* shows that it has only three-fourths of the quantity of nitrogen which we have stated to be contained in farmyard manure. And taking this into account, it would appear probable that the average value of the sea-weed manure may, as regards the nitrogen, be taken as equal to that of ordinary farmyard manure. Exactly the same observation applies to the inorganic constituents, which differ chiefly from those of farmyard manure in containing a smaller quantity of phosphoric acid," (and a larger proportion of chloride of sodium or common salt.)

The above analyses demonstrate the value of sea-weeds as manure, and should have the effect to call far greater attention to their collection and application. If a manure equal in value to farmyard manure may be had on our coasts for the gathering, it is plain that farms within a moderate distance of the shore may be cheaply made exceedingly fertile.

I believe, however, that although their theoretical values, so far as indicated by chemical science in its present stage, may be equal, their actual value as demonstrated by practical results will be found very unequal, *and sometimes in favor of the one and other times in favor of the other.* Careful comparative experiments in various soils and localities are needed to show what it actually is under given circumstances. I find however upon inquiry that farmers by the sea-side rarely esteem it more than half as valuable as ordinary farmyard manure, while those at a greater distance from the shore esteem it more highly. In fact experience has amply shown that its efficacy is much greater when carried into the interior than when used near the sea-side. This is doubtless owing to the fact that some of its constituents are conveyed to some distance inland by the spray and vapors from the ocean in sufficient quantities, and so far as they are thus carried the farther application of these does no good, while beyond they produce marked effects. The same principle holds here as in other manurial applications. If a soil naturally contains or annually receives a sufficiency of any element required by plants, no good effect will be produced by adding more, while most marked results will appear from the use of the same where required.

The efficacy of sea-weed is often, but very erroneously ascribed chiefly to the salt contained in it. This, it is true, is not without its value, but if this were all, the use of sea-weed would be a very expensive mode of applying it. A ton of fresh sea-weed, as we perceive by the analyses, gives about a twentieth of its weight of ash, say one hundred pounds, of which about one-quarter is common salt (chloride of sodium.) Now the price of a peck or a half-bushel of salt would be small pay for collecting and hauling a ton of sea-weed, and if this were all it would be folly to do so. Its chief value probably lies in the nitrogenous compounds and the phosphates which it contains, but not all. As Prof. Anderson remarks, it contains nearly all the constituents required by land plants, and so may be considered a general rather than a special manure. Besides these it contains substances not found elsewhere and which may possibly have some influence, either directly or indirectly. Iodine, in the form of Iodurct of Potassium, is contained in the Fuci, but this fact is of comparatively recent discovery. It doubtless exists also in sea-water, as the plants have no other source from which to obtain it; yet chemists have not been able to find it there, although by the appropriate test, so small a proportion as a thousandth part of one per cent.—a millionth—is readily detected. Who can tell but that this or some other yet undiscovered substance may actually exist in land plants in very minute quantities. If such be the fact, the requisite quantity is necessary, be the proportion ever so small; and the addition of an inappreciable or imperceptible amount might vary results greatly. Such a hypothesis suggests a plausible explanation of the way in which sea-weeds may be effective to an extent not indicated by the results of analytical examination.

I have known of sea-weed having been carted fifteen or twenty miles into the interior and used with satisfactory results. Certainly this could not be the case had it not possessed, for the soil to which it was applied, a value beyond that of farmyard manure, for the cartage alone would have made that cost more than it was worth. A noticeable instance of its efficacy fell under my observation the past summer. A farmer in Penobscot county living from twenty to thirty miles from the sea-coast carried home about ten bushels and applied it very sparingly in several drills where he planted potatoes. The whole piece was otherwise manured alike with a moderate dressing of farmyard manure. The larger and more vigorous growth of the tops was remarkable. The question was put to Dr. E. Holmes of the *Maine Farmer*, who with me examined the piece, How great an additional amount of farm manure would probably be required to produce the effect apparently due to the ten bushels of sea-weed? and his reply was, not less than three loads. Since harvest I have received a statement of the comparative yield of several drills, with and without the sea-weed, as follows:—"Two rows with sea-weed produced two and a half bushels, two rows of the same length side by side without the weed, produced one bushel and two quarts. I took pains to select the land of equal fertility in both cases. The ten bushels of sea-weed gave me, as near as I could judge, eight and a half bushels of potatoes. I was so well pleased with the result that I intend trying it on a larger scale next spring." This shows an increase of about one hundred and thirty per cent. in the yield over the part where barn manure alone was used. At this rate the application of a cord of sea-weed would add to the crop not far from ninety bushels.

Sea-weed usually undergoes rapid decomposition, and if left in heaps in a fresh state, diminishes astonishingly in bulk. Its addition to farmyard manure hastens the decomposition of the latter, and greatly improves its quality.

It may be advantageously used in various modes. Its employment as a top dressing to grass fields usually exhibits great fertilizing power, resulting in a large increase of crop the next year, sometimes for several years, but the results when used in this way are not so uniform nor so lasting as when used in composts or when plowed in green. The cause of such discrepancy, whether due to the character of the soil or to some other cause, I have not been able satisfactorily to determine. As a top dressing for grass some of its efficacy is doubtless due to its action as a mulch, although when thus used it rapidly crumbles down and soon disappears altogether. On some seaside and island farms it is almost the only manure employed, and is used both in composts and as a top dressing, and is often plowed under in a fresh state. Farms thus manured, retain their productiveness year after year, thus proving by experience what chemical analysis teaches us, that sea-weed is a general, rather than a special manure, and like farm-yard manure and unlike superphosphate of lime or other special fertilizer, it furnishes not one only, but nearly or quite all, the elements required by our usually cultivated crops.

To what extent sea-weed may be available to the inland farmer is not yet known. That it may be to a considerable extent seems highly probable as it can be readily dried by exposure to the sun and air to a degree securing it from rapid decomposition and greatly lessening its weight, in which condition it might be conveyed to a considerable distance into the interior. Perhaps in this state it might be screwed into bales like pressed hay, or if it should prove too tough and unyielding, it might if so well dried as to become brittle, be ground, as in a bark mill, and packed in barrels or bags. If it could be dried so as to reduce its weight to one-third of what it is when fresh, I have no doubt it would prove decidedly more valuable to the inland farmer than the poudrette usually sold in manure markets at $1.50 to $2 per barrel, and it could be furnished at a very low price. At my suggestion, several persons have been experimenting on this point the present season, but their results have not yet reached me. Should the manufacture of fish guano become as extensive as it promises to be profitable, the platforms used for drying it might be employed for drying sea-weed during several months before fish become abundant.

A vast trade in partially dried sea-weed, and one profitable to both seller and buyer, is carried on by the fishermen of the west of Ireland, and no reason is known why the same may not be done here.*

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* It was my intention to submit some remarks in this place regarding the substance known as *muscle bed*, (a deposit found in large quantities on the flats adjoining many of our bays and creeks, and which proves a highly valuable and permanent fertilizer on clayey loams near the sea coast, but which is too heavy for transportation to a great distance inland,) but the necessity of sending this portion of my report to the printer at an early day, in order to allow time to publish the reports of the Scientific Survey, obliges me to omit them for the present, it being impossible to write out my notes in season.

Salt. Concerning the value of salt as a fertilizer the most contradictory views have been held. On the one hand it has been extolled as the chief source or sum of all fertilization. The author of the *Jewell House of Art and Nature,* an old book, famous in its day, declares that "it is salt that maketh all seeds and plantes to growe," "that no dungue which is laide on barraine groundes could anie way enrich the same if it were not for the salt which the straw and hay left behind in their putrefaction." On the other hand it has been freely denounced, as in its very nature hostile to vegetation. To prove this some old writers quote scripture (XXIX Deut.) and say that its being coupled with burning and brimstone amply shows its noxious character, as also is the custom of sowing subjugated cities with salt (Judges IX: 45) to ensure perpetual sterility. If the Bible had been written to teach agriculture, these passages might be more pertinent to the case. As it is, it would not be difficult to show that its use as a *fertilizer* was known in early times, as we are also told that "*salt is good,*" but salt which lost its saltness—that is, mineral salt, containing earthy impurities, from which the salt had been washed out by rains, leaving only the inert matters—is good for nothing, unless to make roads of, being fit neither to apply directly to the land, nor yet to mix in a compost heap.

Experience has amply shown that the employment of salt in agriculture has frequently been attended with injurious results, and it has just as plainly demonstrated also that its judicious use has proved beneficial. Regarding no single substance is there so great need of accurate comparative experiments and scientific research to determine its uses and value and the proper modes of using it as this, for notwithstanding the great length of time during which salt has been used for agricultural purposes there is yet considerable doubt as to its action and value. From the facts within my knowledge I am convinced that it possesses great efficacy when properly used. We all know how near Peruvian guano came to being discarded as a noxious substance, on its first being introduced into England, from the many failures of crops which we now know to be wholly due to its injudicious employment. Several millions of bushels of salt are now said to be used in England annually for fertilizing purposes, and if this is profitably done in a "sea-girt isle" where so much is every year deposited on the land by natural causes, it is reasonable to suppose that its use at a longer distance from sea-spray and salt vapors would be attended with still greater advantage.

The chemical composition of salt is about 40 per cent. of sodium (the base of soda) and about 60 per cent. of chlorine. Hence its name, *Chloride of Sodium*. The salt of commerce generally contains more or less of impurities, one of the most common of which, in salt prepared from sea-water, is chloride of magnesium, and often amounts to two or three per cent. This being a very deliquescent salt, attracts moisture from the air, and when such is applied to land it secures to the soil a perceptible degree of moisture. When dissolved in water, salt or chloride of sodium, becomes *muriate of soda* by the decomposition of water, and the union of its hydrogen with the chlorine forming muriatic acid, and of its oxygen with the sodium to form soda. Salt when dissolved in water is decomposed by lime; the latter, having a stronger affinity for muriatic acid than soda, unites with it, leaving the soda free. The soda thus set free possesses alkaline properties similar to potash and is valuable both for itself and especially by its action on peat or muck. One of the most economical composts for many uses which the farmer can use, where lime and salt are reasonably cheap, is made by spreading quick lime on a layer of muck and slaking it with water saturated with salt and intimately mixing the whole. A bushel of salt, a barrel of quick lime and fifty bushels of muck are fair proportions in which to use them. The effect is so to change the vegetable matter of the muck as to render it available for plant food.

Salt forms a constituent of some plants and to such extent it is itself a direct plant food. Root crops are more benefited by it than grain. For mangolds it is especially necessary and almost indispensable to a good crop. Many have found salt with manure to prove more effective for turnips than double the quantity of manure alone. One part manure and three parts salted peat or muck has been found to produce more potatoes and turnips than four parts of barnyard manure alone.

Pasture is often benefited by a moderate application of salt, the feed being rendered both more abundant and more palatable and nutritious. Its benefit here, as in many other cases, will be much in proportion to the distance from the sea from whence salt may be brought in spray or vapors.

The application of salt to grain crops has been extensively proved, and in very many instances has been attended with good results.

Wheat and barley are more benefited by it than oats. It is usually applied broadcast after the grain is well started at the rate of five or six bushels per acre. Sometimes much heavier dressings have been made, but caution should be used and no heavy applications be made except after first trying it in moderate amount. Salt has a tendency to retard germination, and growth also in its earlier stages, but it strengthens the after growth. Roots, as potatoes, turnips and mangolds are more solid from its use and more nutritious. It causes grain to become heavier in the ear and shorter in the straw—many think the straw stiffer as well as shorter. It certainly hastens its maturity, lessens the liability to lodge and to rust and gives a brighter straw.

From a valuable paper by Prof. Voelcker of the Royal Agricultural College, I give some extracts. "The utility of salt in feeding and fattening stock is highly spoken of by many practical feeders, while others deny that it is of great use to animals. There can be little doubt however, that salt in moderate rations is conducive to the general health of animals, for it is largely required for the formation of blood and various animal juices. Animals, especially sheep, are very fond of it. Salt is said to prevent rot, scab, intestinal worms and other diseases, which they are liable to contract from unfavorableness of situation or change of climate. It increases their appetite, promotes the power of digestion and modifies their natural timidity, and may therefore be given with advantage to them in moderate quantities twice or three times a week.

Salt is a never-failing constituent of all articles of food upon which our domestic animals are usually fed; but as the proportion of salt in the several kinds of food is very variable, the utility of salt in feeding or fattening will be greatest when food is supplied naturally deficient in this compound.

Beneficial as salt may be, under some circumstances, to the higher animals, it is decidedly pernicious to those of the lower orders. Even in small quantities it operates fatally on cold-blooded animals; and is therefore used with advantage for destroying worms, newts and most insects. A strong solution of salt is a convenient agent for destroying slugs and other vermin in the ground, and as, at the same time, it kills weeds, it may be used for keeping gravel walks in good order. A sprinkling of salt on lawns at the rate of ten bushels per acre, is said to prevent worm-casts and to give greater vigor to the grass.

A strong solution of salt is sometimes used for steeping seed wheat as a preventive against smut; but as sulphate of copper is a much more certain means we would not recommend the use of salt. Salt has been applied to the land in various other ways, to prevent rust, mildew and other fungous diseases of the cereal crops.

Common salt has been employed in all ages and in all countries for the purposes of promoting vegetation, and has been found especially useful in inland countries. In some districts it has failed to produce any beneficial effects upon the growing crop, and has consequently suffered in the high estimation in which it was held in England a century ago. Still salt is largely employed for manuring purposes, and there is no doubt that in many cases it produces a sensible improvement in various crops. Its use has been particularly recommended for the cereal crops; and numerous experiments have been published from time to time in which the application of salt has produced a considerable increase in the yield of wheat, barley and oats. Thus Mr. C. Johnson found it answered exceedingly well on a light and gravelly soil in Essex. The produce per acre, on a part which had not been manured for four years, was found to be 17 bushels and 26 pounds; and on a part which he manured with five bushels of salt per acre, and which likewise had not received any manure for four years, the yield of wheat amounted to 26 bushels and 12 lbs. In a comparative experiment on a part which he manured with stable dung, to a crop of potatoes in the preceeding year, he obtained 26 bushels and 52 lbs. Mr. C. Johnson is, accordingly, a great advocate for salt as a manure for wheat, and recommends it to be applied some time before sowing the seed in a dose of no less than ten bushels and nor more than twenty bushels per acre. Many others also speak very highly of salt as a manure for wheat.

The use of salt was found less beneficial by Mr. Fleming on oats—the increase over the unsalted portion being only two bushels per acre. On barley a very large increase was obtained by Mr. Ransome in Suffolk. Without salt the crop was thirty bushels, and sixteen bushels of salt raised the produce to fifty-one bushels. Many other experiments on grain crops might be named, but are omitted, as for the most part they were not conducted with the requisite care and accuracy.

Salt is said to give strength to the straw, and theoretical reasoning leads us to expect this, but whether it is really the case or not has never been determined by direct experiments. Neither theoretical speculation, vague statements nor solitary practical observation can establish so important a fact, which can only be proved by the rigorous tests of a series of well conducted comparative experiments.

The use of salt for root crops has also been highly recommended; and in some experiments by Mr. McLean of Mid Lothian, a considerable increase in the turnip crop was observed by the addition of four cwt. of salt to thirty carts of dung per acre. Root crops, especially mangolds, contain a considerable proportion of common salt and it is therefore very probable they will be benefited by a generous supply. It has been estimated by Prof. Way that turnips contain according to the average of his trials about two pounds of common salt in every ton of bulbs, and mangold wurzel 6½ pounds. These analytical remarks lead us to expect that salt will be highly favorable to the luxuriant growth of root crops and in an especial manner to that of mangold wurzel.

It is well known that a saturated solution of salt is capable of killing weeds, and we know further that some plants are injured by a dose of salt which decidedly improves others. There have been made as yet few precise experiments with a view of determining in what quantities and under what conditions salt exercises a beneficial effect upon our various cultivated crops. That salt affects various plants differently will be seen from a series of experiments which we made some years ago with a view of ascertaining in what quantities salt exercises an injurious and when a beneficial effect. The following is a summary of the results of these experiments.

1. Salt solutions containing 3 grains of salt per pint, or 6 grains, 12 grains, and even 24 grains of salt per pint, produced no injurious effects on cabbages, field beans, onions, chickweed, (*Stellaria media,*) thistle, (*Carduus pratensis,*) annual meadow grass, (*Poa annua,*) radishes, (common long red,) which were watered regularly with these solutions during two months. Plants of sweet scented vernal grass were killed by a solution of 24 grains to the pint after the lapse of one month.

2. Such weak solutions appeared to benefit most plants experimented upon, especially cabbages and radishes. All had a fresher and more luxuriant appearance than those watered with rain water only.

3. Salt solutions containing 48 grains per pint, exercised a prejudicial effect in the course of a month on the chickweed and annual meadow grass, but had no injurious effect on cabbages, field beans, onions, radishes and thistles.

4. Salt solutions containing 96 grains per pint, exercised an injurious effect upon cabbages and field beans, but did not injure onions, radishes and thistles regularly watered with solutions during two months.

5. Cabbages will continue to grow, though sickly, when watered regularly during a month with a salt solution containing 192 grains of salt per pint, and even when watered with a solution containing 384 grains of salt per pint.

6. A solution of salt containing 192 grains per pint, proved prejudicial to onions regularly watered with it during one month.

7. A solution of salt containing 24 grains to the pint decidedly benefited radishes, onions and cabbages.

8. Grasses are affected by salt more readily than any other of the plants experimented upon.

9. Bulbous plants, and plants with succulant leaves are especially benefited by the application of salt.

Many of the plants in these experiments had taken up so large a quantity of salt that they tasted quite saline, but notwithstanding this they grew healthily. This evidently shows that salt in moderately dilute solution, can be taken up by many plants without exercising a pernicious effect.

In many cases in which salt has been applied to the land it has failed to produce a sensible improvement of the growing crop; but in examining the circumstances under which it was unsuccessfully employed we shall frequently be able to point out the cause of the failure if we pay due regard to the following considerations:

1. The neighborhood of the sea must necessarily interfere with its action. On land situated along or near the sea-coast or which is exposed to the action of prevailing sea winds, the application of salt will in most cases prove useless, because the soil in such localities contains already sufficient to satisfy the wants of the growing crops. It is well known that the spray of the sea is constantly borne by the winds to a great distance. Moreover the clouds which form over the sea contain a greater or less amount of salt which will be deposited in the soil by the rain. In England rain seldom falls in which a sensible portion of salt cannot be de-

tected by delicate tests, and this no doubt explains at once why the application of salt to the land in continental countries has been attended with much better results than in England, and most of the failures which have occurred from its use have been experienced on farms exposed to the sea.

2. Some soils, in inland districts contain salt; and the presence of deposits of salt, or the occurrence of salt springs, affords indications that on land near such localities the application of salt will be unprofitable.

3. Salt is not a universal manure and for this reason it cannot supersede the use of other manures.

4. Where salt is freely given to the stock, their manure will contain much of it, and so its application otherwise will be less effective.

5. In dry seasons, common salt, like other saline manures, exercises little or no effect if supplied in moderate quantities, but may prove injurious when used in large doses."

Salt, as all know, is largely employed to preserve meats from putrefaction by its antiseptic quality. Perhaps it is less generally known that in small quantities its effects are just the reverse—it promotes putrefaction, and hence one use of salt, and a very important one to the farmer, is in compost heaps, to facilitate the decay of organic substances and bring them into condition to become nutritious food for plants, and while salt does this it is not spent or lost, but itself becomes a substantial and valuable addition to the heap. Some of the most successful farmers and gardeners I have ever known, invariably use salt in their composts, and could not be persuaded to forego its employment.

The use of salt in sufficient quantities will arrest the fermentation of animal manures, and thus by varying the amount used, the decomposition can be regulated, so as neither to be too slow or too rapid, and thus preserve all its fertilizing elements. So far as my observation extends, the use of salt among the farmers of Maine is steadily increasing. I have met some the past season who use from one hundred to two hundred bushels a year, and with manifest advantage—employing it both for grain crops, (chiefly barley,) root crops, in composts and sometimes as the top dressing to grass and pasture lands. I believe it to be worthy more extensive use.

CULTIVATION A FERTILIZING AGENCY, AS REALLY AS MANURE. In our need of means to render agriculture more productive it has been customary to rank manure as the principal agency, and a sufficient supply of it, as the one thing needful. Manure, we have been told, is the food of plants; that by its application we must supply what the plants need which they cannot get from the soil, so that they may make vigorous growth. We are also informed of the amount and nature of the mineral matters taken from the soil by the crop, and which needs to be returned to, or replaced in, the soil to save it from exhaustion. The importance of manure is not for a moment to be doubted, but it may be questioned, whether in seeking for this, we have not failed to attach due importance to another agency, viz., cultivation, or tillage. In many cases, and probably in the majority of instances, with what is commonly known as *strong* land there is a considerable proportion of its constituents in a condition unavailable as immediate food for plants, but which needs only to be finely pulverized, and exposed to the decomposing influence of air and water and frost, to be brought into a condition to feed plants, and that rapidly enough to secure a vigorous growth. The practice of bare fallowing is a very ancient one, and until within a century or two was the chief means employed to restore the fertility of worn out soils. Its efficacy was believed to arise from a supposed necessity of allowing the land *to rest*, as if it were possible for an inorganic substance to become fatigued with bearing, like an organized, living being. When the absurdity of this idea was realized, the practice of fallowing came to be distrusted because supposed to rest on a false theory. The fact is, that the success which attends fallowing depends upon changes, both mechanical and chemical, which take place in the soil by means of pulverization and weathering, and these are very considerable. I have very little doubt that upon our strong clayey lands the practice might be revived with advantageous results, particularly if accompanied with the application of lime. The theory of Tull, that fine particles of soil constitute the food of plants, we now know to be erroneous, nevertheless practice based on that theory produces highly satisfactory results; not because plants are fed directly upon soil, but because by pulverizing the soil we secure the liberation of plant food which before was locked up by reason of being in a condition in which plants could get no good from it. This fact may also serve to show in a forcible light one reason why the results of chemical analysis cannot always be depended on to indicate the degree of fertility to be expected of a given soil. The chemist tells us truly of what it is composed, but in order to get at his results he subjects the sample of soil given him to various processes, including the utmost degree of pulverization and the action of powerful solvents, processes which are not repeated nor even imitated by the farmer unless in the faintest degree possible.

Let us consider for a moment the origin of soils. When we look at a ledge or boulder of solid rock, (and the time was when the whole surface of the earth was only rocks,) we find it supporting only the lowest grade of vegetable life—lichens, unfit to support man or beast. Let this same rock be crushed or crumbled to a coarse powder, (and it matters not whether this be accomplished by mechanical blows or by natural agencies,) let it be exposed to the air and frosts, and wet with rains, and we soon find the same material capable of supporting a higher grade of plants, and by degrees, as these perish on its surface and become mingled with its substance, its quality improves, both by the addition of the organic matter of the plants grown upon it and perhaps by the remains of animals fed upon them, and also by the gradual decomposition of the stony matter which yields up more and more of its constituents in such an altered form that they may now become the food of still more and better plants.

The quality of soils will of course depend very largely upon the character of the rocks which form its basis, but if these be good it is evident that the soil will attain its highest fertility when all its particles are in the finest state of division possible. Now we all know that common soils are far from being in such a finely divided state. A part of most soils is fine, more is coarse, and much is coarser still. It is one great object of tillage to effect this division and to expose all its particles to the decomposing agencies of nature, and so to make it available in the highest degree for plants. Tillage does not directly add to the soil, as manure does, but by developing its hidden capabilities, and also in other ways, really enriches it.

Something more than a century ago Jethro Tull published a work on agriculture in which he held that earth is the true pabulum of plants; that to secure the highest fertility it is only needful to reduce the soil to the most finely divided state; that the action of dung was merely to ferment and crumble the particles of earth finer and finer. He also advanced other notions so opposed to prevailing views and practices, and I may add, so different from what science has since taught us, that he was looked upon and by many is still supposed to have been only an absurd theorist. But in truth Tull's practice was far better than his theories; and making due allowance for the very imperfect knowledge of the sciences related to agriculture, of that period, it must be acknowledged that Tull's views were those of a deeply observant and philosophical mind, and they are every year attracting increased attention. Tull advocated the constant subdivision of the soil by abundant cultivation, and the arguments by which he supported the practice were chiefly two. The first, that by the breaking up and subdivision of the particles of soil, a new and constantly increasing food yielding surface, or as he called it, "pasture" was provided for the roots of plants. His second argument was, that by the continual opening and loosening of the soil opportunity was given for the air to enter it and to confer increased fertility. Tull knew little or nothing of the real nature of these atmospheric influences, for when he wrote, even the names of carbonic acid and ammonia were unknown, but he was nevertheless fully convinced by close observation and experiment that the air did exercise a beneficial influence on the soil, and his endeavor was to secure that influence to its fullest extent, and here he was right and his practice worthy of being greatly extended.

In a word, tillage operations are as really a means of fertilization as the application of barnyard manure or any other substance, and this not because they add anything to the soil, but because they develop from within the soil resources which before were of no practical value.

The subject is one of great importance and worthy of more attention than has hitherto been bestowed upon it, and I am happy to give below the views of Mr. Henry Tanner, Professor of Agriculture, Queen's College, Birmingham, as lately published in a foreign agricultural journal:

"In order that a clear view may be taken of the relative value of cultivation and manure as fertilizing agents, it is necessary that the nature of the soil should be examined, and its general properties understood. Soils may be considered as consisting of matter in three distinct conditions. The first has been termed *the active matter* of soils, because it exists in a condition capable of being dissolved in water, and consequently available for entering into the circulation of plants and ministering to their growth. It has therefore received the term *active*, as being ready for the immediate discharge of its duties; and in this respect it differs very materially from the two other portions of the soil. The second portion has been named the *dormant* matter of the soil, not that it is dead or useless, but simply in a state of inactivity, being insoluble in water, and therefore unfitted for entering into plants. It might, however, be said that all matter which is not active must be dormant, and this is quite true; but for the convenience of more clearly explaining the component parts of the soil, a further division has been found desirable, and hence we have a third portion, or the *grit* of the soil. We must, therefore, view the soil not as a homogeneous mass, but as consisting of ingredients congregated into three classes, as—

The *active* matter of the soil;
The *dormant* matter of the soil; and
The *gritty* portion.

By the aid of chemical analysis, each of these may be again subdivided into the several ingredients of which it may be composed. It will at once be evident that an analysis of the entire mass of the soil would give information which must be looked upon with caution, and used with discretion. If an agriculturist wishes to know the composition of any particular soil, it is manifest that he requires, not an examination of the entire soil, but to know the constituents which compose the *active ingredients* of the soil, for these are the materials which influence the immediate fertility of the soil, and regulate its productive character.

If you examine the three classes already named, you will see that they are simply distinct stages, through which the soil has progressed or is progressing. We have the grit or stony portion—the type of the original rocks, from which all soils are produced—and these are the fractured particles which have withstood the disintegrating action of the atmospheric agencies for a longer period than the other portions. But as under the crumbling influence of the air, moisture, and change of temperature, these become broken up into a smaller and finer state, this gritty matter changes into the dormant matter of our soils, in condition and appearance forming part of the soil, but still insoluble, and therefore valueless as food for vegetation. Such then is the matter of the second class, or the dormant portion—viz., the finely disintegrated portions of the rocks and stones, apparently available for vegetable growth, but still not in a condition to fulfil that expectation. When, however, the dormant matter has been more fully acted upon by the chemical agents in the rain and air, then its character alters, and it no longer remains insoluble, but it readily dissolves in water, and consequently assumes the active condition. Thus, each of these stages is a progressive advance,—the *grit* will ultimately become the pulverized *dormant* matter, and this will advance into the *active* condition. For these reasons we may consider—

The active ingredients of the soil as the portion ready for immediate use;

The dormant portion to be rendered useful by cultivation;

The grit which is the store for future years.

We have every reason to believe that each of these portions may be composed of matter equally valuable as fertilizing agents, but differing only in one respect—viz., the time of their being available for use. Dr. Daubeny proposed the two appropriate terms of "*active*" and "*dormant*" for the two conditions already described, and, in a communication to the Royal Agricultural Society, has shown the extent to which this distinction exists in soils. From the analysis given, it appears that about one-half of the alkalies, and one-eighth of the phosphoric acid, were in active form in the soils examined, and the remainder were *dormant*. If, therefore, a person had estimated the powers of the soil by its full analysis, he would have anticipated the aid of nearly double the quantity of alkaline matter, and eight times the quantity of phosphoric acid, which really existed in a form available for immediate use.

I shall now proceed to show the manner in which bodies existing in the soil in a *dormant* condition can be rendered active, and thereby available for the process of vegetation. I need not do more than remind you that two agencies are very influential in accomplishing this. These are rain water and changes of temperature. Rain water is not *pure* water, but as it falls through the air it dissolves carbonic acid gas existing there. It also carries with it some of the atmospheric air, and these gases, being conveyed into the soil, perform very important duties, and contribute to the one which now claims our attention—viz., the conversion of the dormant ingredients of the soil into the active condition. Chemical research has proved that carbonic acid and oxygen co-operate in carrying on a slow and almost imperceptible action upon the ingredients of the soil, thereby changing the insoluble gritty matter of our soils into dormant matter, this again into the more complete and active state, and then they assist in the final appropriation of it by the crop. Thus, the same agents co-operate throughout the entire change, and enable matter to assume these new forms. This action is of a chemical character, but it is powerfully promoted by the mechanical assistance rendered by changes of temperature. The influence of this is to be traced to the fact that bodies when they are hot occupy more space than when they are cold; hence, by rendering a body hot and cold, you weaken its cohesive power. This is especially observable when the change of temperature is great, or when water is present in the soil. All have noticed the effects of frost upon the clods of soil in our fields—how the frost binds them together with the hardness of a rock, and, when it thaws, crumbles them into a powder. This same action takes place *in the particles of the soil*, in a greater or less degree, according as they may be more or less exposed to the influence, and this breaking up of the soil exposes fresh portions to the action of the chemical agents spoken of. Thus the combined action of these very simple agents accomplishes by slow but steady action very material changes in the soil, rendering its fertilizing ingredients available for our use, and unlocking the stores which nature has made for our present and future requirements. This is a very hasty sketch of the materials which we have to deal with; but we must go on to show in what manner the processes of cultivation render the soil more fertile by the development of its own resources.

The tillage of the land is designed to prepare it for the germination of the seed, and, finally, the perfection of the crop. For the accomplishment of the former, the land has to be brought into a state favorable for the germination of the seed, or, in more general terms, I should say, into that free and loose condition which is known to be so necessary a preparation for sowing. This condition, which is favorable for the first growth, is equally so for the subsequent perfection of the crop. The operations by which this result is gained consist of ploughing, rolling, harrowing, &c., and these are very beneficial in increasing the fertility of the land. In fact, we may view them as so many means for exposing the various parts of the soil to the action of the air, rain, frost and light.

I have already stated that the carbonic acid and oxygen carried into the soil promote the chemical changes which awaken the dormant ingredients of the soil, and bring them into active exercise. In like manner, those parts of the soil which are upon the surface are exposed to these chemical changes, and thus a ceaseless action appears to be going on between them. This change is one by which the mineral matter of the soil is acted upon; but, in addition to this, we have other changes produced—viz., the decay of the *organic matter* of the soil—for the air and moisture promote changes in its character, and thus render it valuable for promoting vegetable nutrition. It is, however, worthy of note that, whilst the organic matter of the soil is undergoing decay or decomposition, this change favors and promotes the conversion of the mineral matter of the soil from a comparative useless state into a condition suited for the want of our crops. Any process or operation which stirs the soil, and brings fresh portions under the influence of decomposition, promotes these changes in the organic and the mineral matter of the soil, thereby rendering them available for the nutrition of our crops.

In this manner *the stores of the soil are opened up and rendered useful*; but I have now to show that tillage operations not only accomplish this desirable result, but they also prepare the soil for abstracting from the atmosphere fertilizing matter. The value of ammonia as a manure is well known, and upon its action the beneficial character of many of our manures is based. It is an expensive manure, but still its judicious use is remunerative in a very high degree. We send many thousands of miles for a large portion of our supplies, yet it is found in the atmosphere floating around us, and is there present in a condition available for the use of vegetation. It is not necessary or desirable for me to refer to the sources from whence it is supplied to the atmosphere; it is enough for us to know the valuable fact that there are abundant stores prepared for the cultivator who is ready to receive a supply therefrom. It is with great pleasure that I refer to a very valuable contribution to our knowledge of the principles which regulate agricultural practice by Professor Way. It will be found in the sixteenth volume of the Royal Agricultural Society's Journal. He there proves the presence of nitric acid and ammonia in the atmosphere; that these bodies are removed from the air in two ways—by the absorptive powers of the soil, and by the rain dissolving them and carrying them into the soil. He very judiciously remarks: 'The atmosphere is to the farmer like the sea to the fisherman, and he who spreads his nets the widest will catch the most.' It is not that all land derives equal advantage from this magazine of wealth, but land receives and profits just in proportion as the industry and intelligence of man render it capable of drinking in these fertilizing matters.

Thus you observe there are two channels through which the nitric acid and ammonia of the atmosphere become introduced into the soil—the one by the direct absorptive powers of the soil, and the other by the intervention of rain bringing fresh stores within reach of the soil. With regard to the former of them, I may say, that although it does not come properly within the limits of the subject under our notice, still the practical connection is so manifest that I shall not refrain from going into some brief notice of it; but before doing so, I shall notice the agency of rain. This must be viewed as an assistant agent which gathers the accumulations in the atmosphere, and brings them within the influence of the absorptive powers of the soil. If, therefore, such rain passes away on the surface without entering into the soil, it is manifest that its services are lost. Hence land which by natural or artificial drainage allows the rain to pass through it, carries into the soil its hidden treasure, which in any other case would pass away to some other recipient, or to the nearest streamlet. The value of the assistance to any agriculturalist simply depends upon its services being accepted and turned to some useful account, or else rejected, and its agency wasted.

We may now notice the absorbent powers of our soils. The researches of Professor Way (published in the *Journal of the Royal Agricultural Society*, volume 15), are of the deepest importance to agriculturists. I will, therefore, briefly bring before you the results of these researches. It was observed that, when a solution containing ammonia (or other alkaline salts) was passed through a portion of soil, the soil separated the ammonia from the liquid, preserving it from being again washed out of the soil; and this action was finally traced to the presence of bodies in the soil, known as the double silicates. A silicate is a compound of silica with another body—say, for instance, silica and soda produce a silicate of soda—but the double silicates are very peculiar, for in these we have silica combining not with one body but with two bodies: for example, there is the double silicate of soda and alumina; the double silicate of lime and alumina; and a third, which is the double silicate of ammonia and alumina. But you will observe that alumina is present in each, and the only difference is that soda is present in the first, lime is present in the second, and ammonia in the third. In most soils we find these double silicates present, but their value varies very considerably. We may now observe the difference in their character and mode of action. The double silicate of soda and the double silicate of lime are each capable of separating ammonia when it is dissolved in water, but the double silicate of lime alone has the power of separating ammonia from the air; the double silicate of lime is, therefore, decidedly the more valuable salt of the two. The double silicate of soda is readily converted into the double silicate of lime when lime is added to the soil, consequently the addition of lime to the soil renders it competent to absorb more ammodia from the atmosphere, and thereby gives it greater powers of acquiring fertilizing matter than it previously possessed.

In addition to this benefit another desirable result has been attained by the use of lime—viz., that, as nearly all soils contain ammonia in them in a dormant state, the use of lime displaces part of this ammonia, and thereby this fertilizing matter becomes available for the plants growing in the land.

Thus it is seen that in the soil there are bodies capable of separating ammonia from the rain as well as from the atmosphere, and afterwards preserving these fertilizing stores until required for the crop. We have in the use of lime a double advantage; it not only gives the soil superior powers of acquiring that valuable fertilizing matter ammonia, but it also renders the existing stores of dormant ammonia ready for active service in promoting vegetation. It is, however, of no practical value to us having in our soils the means of accumulating fertilizing matter, if at the same time we place it in a position in which this power is rendered inoperative; consequently we have two means by which to promote the accumulation of ammonia in the soil, and these are—1st, increasing the capabilities of the soil to absorb ammonia; and, 2d, giving the atmosphere a free access to the soil, so that these powers may come into full operation. The addition of lime to the land has in this respect a double action—viz., it sets part of the ammonia in the soil free and available for promoting vegetable growth, and it also renders the soil more competent for accumulating a store which will maintain the fertility of the land; and thus we have in the use of lime as a manure, a valuable means of realizing the first requirement—an increased absorbing power. The attention may now, however, be advantageously directed to the facilities for the increase of these powers, and these are manifestly twofold—viz., the exposure of the soil fully to the air, and the passage of rain through the land. The tillage of the land is therefore just the agency required to accomplish this desirable result; for as I have said before, the inversion, stirring, and crushing of the soil by the various operations of ploughing, cultivating, harrowing, and rolling, each and all promote the exposure of fresh portions of the soil for atmospheric action; and whatever capability is possessed for the secretion of ammonia, the soil is thus furnished with the opportunity for its exercise.

If you view our field labor as so many means for exposing every portion of the surface soil to the air, you will at once realize the value of many operations which we have hitherto only considered as of mechanical value in preparing the land for seed, by rendering it light, and giving the roots freedom for their growth and extension. But the advantages are double; for not only is it necessary for the luxuriant growth of a crop that it should be so placed that its roots have a freedom of action for searching after the food which the crop requires, but, as I have already explained, the means we adopt for attaining this result equally facilitate the success of the crop by the accumulation of fertilizing matter which is being simultaneously made. This free and loose condition of the soil is equally favorable for the passage of rain *into* the soil; and when this is properly assisted by an efficient under-drainage, then alone is the full advantage derived from the rain and its fertilizing contents.

With a knowledge of these principles, if you review that old established practice of fallowing, you will not fail to detect the reason for past success in this practice, and you will see another instance of that true union which exists between practice and science, which every lover of agricultural progress hails with feelings of pleasure. The true principle of fallowing has been to expose the land to the wind, rain, frost, and heat, and to keep the land moving as much as possible. Manifest have been the advantages derived from extra ploughing, which *to the eye* appeared at the time productive of little change or benefit, but the succeeding crop has in many such cases given evidence of increased capabilities of production, which, until lately, has been set down as simply resulting from the mechanical condition of the soil being more favorable for growth, instead of its being also referred in part to the increase of food for the crop which was thus obtained.

The use of lime for fallows is an old established practice loudly decried by some as exhausting to the land, but still the practice was continued, because it was found to succeed; and now the practice has, by its successful results, survived the period of its condemnation, and entered into one of more honor, in which both practice and science agree to sanction and advise its use. Here let us all take a lesson for our future guidance, and remember that old established and successful practice has truth for its foundation, and although there may also be some error intermixed with it, yet we shall be unwise to condemn any successful practice as useless which our present imperfect knowledge cannot exactly approve of.

We have now to notice the influence of tillage operations upon the organic matter of the soil; and, without going into any unnecessary detail, I may remind you that the passage of rain water (and its associates from the atmospheric air) into the soil very materially assists in promoting the decay of these organic matters, and renders them serviceable for the support of vegetation. Thus every portion of the soil derives advantage from the tillage operations to which it is subjected. The mineral matter of the soil which is in an active condition is thus enabled to pass into the circulation of plants. Those portions of the soil which are not in an advanced stage, but lie *dormant* in the soil, are by the same power awakened to action, and transferred into an active state; whilst the insoluble grit of the soil has also gradually progressed into the next stage, or the dormant condition. The stores of ammonia which the atmosphere contains are gathered by the soil, and subsequently liberated when required by a growing crop; whilst the organic matter of the soil is also by the same agency prepared to minister to vegetable productiveness. Thus we have nearly all the requirements of our crops supplied from natural sources, and these are rendered available by our various tillage operations.

The conclusion to which we are brought by these facts is, that tillage operations render free and available for vegetation certain fertilizing matters which are essential for our crops, and that the degree to which the resources of any soil are developed is proportioned to the extent of these operations. Practically it matters but little whether so much alkaline matter, ammonia, and organic matter is added to the soil by manure, or converted from a dormant to an active condition. It is manifest that in both cases the soil is equally enriched by equal quantities of the same materials; but there is this advantage in favor of the tillage operations, that whilst the two methods may be equal in a chemical point of view, yet the mechanical conditions are very materially in favor of cultivation as a substitute for manure. The food being the same, equal results would be obtained, provided other conditions were equal; but if the mechanical condition of the soil is very much improved, it will enable the crop to grow more freely, and this is so much the more advantageous for the increase of the crop resulting from our tillage operations.

But what are the practical inferences we are to draw from these principles? Are we to consider our farms independent of our various manures? This would certainly be a premature conclusion. We see how advantageous the use of lime is, and our arguments are certainly in favor of its frequent employment in moderate quantities. It is equally clear that there is a great difference in soils as regards the mineral matter they contain; for if they do not possess the several ingredients which the crops require, our tillage operations cannot develop them, and hence such soils will still be dependent upon the supply of manure for fitting them for being productive.

Those soils which possess rich stores of the mineral matter required by plants will be enabled to yield them to vegetation under the assistance of good cultivation. But as the majority of our soils are very deficient in phosphates, and as these valuable fertilizers, even upon well-managed farms, are being continuously removed from the land, and do not in regular course of farm management find their way back again to the land, it is evident that few soils could withstand the removal of this important group of manures without some return being made periodically, and hence we may fairly anticipate considerable advantage from the continued employment of phosphatic manures. The value of farmyard manure will still be equally great, and its economical value will not be depreciated because of tillage operations being in some manner a substitute. They must rather stand side by side as valuable cooperators in the same service, and not be looked upon as competitors. We must not prize our manures less, but value cultivation more highly; and I have no doubt that thus the standard of our crops will be materially raised, especially if an active cultivation of the land is supported by a well-managed homestead, in which food is economically consumed, and the manure carefully preserved and prepared for the use of the farm.

You may, however, justly require of me some practical results in support of the principles named. This I can readily furnish. In fact, I have already based my arguments upon the success which has generally attended the practice of fallowing, and upon which most conclusive evidence is to be obtained throughout the country. I should, however, be guilty of a great oversight if I omitted to make reference to the 'Lois Weedon' system as another illustration of the principles I have already specified. Much as this has been a bone of contention both among practical farmers in different districts, as well as amongst scientific men, as to the principles involved, still I feel that I must not avoid making reference to it. Whatever may be our preconceived ideas respecting the nutrition of plants and the exhaustion of the soil, still here we have a fact establishing beyond doubt that wheat may be grown year after year upon land of moderate fertility; and notwithstanding that the soil has not been enriched by the use of manure, still the land has progressively increased in fertility, and the crops become more abundant and of superior quality. It is desirable that I should briefly notice some of the peculiarities of this system. The plan adopted by the Rev. S. Smith at Lois Weedon, in Northamptonshire, is to divide the field into lands five feet wide. In the centre of these lands, the wheat is dibbled at the rate of two pecks per acre in three rows, one foot apart, thus leaving a space of three feet in width unoccupied. When the plant is up strong, the whole of the land is dug with a fork and allowed to lie rough for the winter. In the following spring the land is levelled and well cleaned by the use of the horse-hoe, and this implement is freely used until the wheat is coming into blossom. The rows of wheat are then earthed-up with a mould-board, and in the furrows thus made the subsoil plough is used tolerably deep. To overcome the injurious influence on the wheat, which is found to arise from the land being too loose, the Crosskill roller is used before the ground is sown, and also in the following spring. In this manner one-half of the ground is occupied in producing wheat, whilst the remaining half is under fallow in preparation for the next year's crop. Under this system the produce of this land (not worth 30s. per acre) has been raised from 16 to 40 bushels per acre. The crops from 1847 to 1856 inclusive, averaged 34 bushels; the crop of 1857 produced 36 bushels; the crop of 1858 equalled 40 bushels: and thus the land, instead of showing any sign of exhaustion, gives proof of increasing fertility. The question naturally arises, to what source are we to trace these anomalous circumstances, that with the repeated removal of these crops, without any compensation by manure, the soil advances in fertility? It can be referred to no other causes than those I have already named—the conversion of the dormant matter of the soil into an active condition, whilst at the same time, and under the same agency, the soil feeds upon the nitrogenized matter of the atmosphere, and secretes a store of food for the growth of the succeeding crop. With facts before us like these, it is folly to doubt the possibility of such being done, or to set it aside as an incredible story. It would, however, be equally wrong to entertain the idea that the same results would be attained under other circumstances. Doubtless, there is much land upon which equally satisfactory results may be realized, but there are also many districts in which the system could not be followed out remuneratively. A moment's consideration will prove this. To produce a crop of wheat, the land has to yield up not only nitrogen in a state fitted for assimilation, but also mineral matter, and without these supplies a luxuriant crop cannot be produced. The nitrogen may be derived from two sources, the soil and the air; but *the mineral matter can only be supplied from the* SOIL. If by any plan we can render these supplies available with greater rapidity than the crops draw upon the land, then the productive powers of the soil are not reduced from the loss; but under other circumstances, the land must gradually become less productive. The plan adopted at Lois Weedon succeeds in maintaining the productive character of the land, and its success may be traced to two circumstances.

First—That the soil contains the necessary supplies of mineral matter ready for being brought into use; and

Second—That the tillage operations are capable of rendering these supplies available.

The absence of either of these conditions must produce a failure; for if the required mineral matter were absent from the soil, no amount of tillage could produce it; and so also if the mineral matter were present, but under circumstances which would not allow of its being rendered available, it could not be of any service to the crop. This is a system which can only be fully carried out upon soils possessing certain mineral ingredients required for the wheat crop, for its chief merit consists in *the development of hidden or dormant stores of fertility* which may exist in soils when little expected. In the case of the Lois Weedon soil, we have a thorough wheat soil, and hence its powers are brought into action; but whereas you cannot develop properties which are not possessed, you must not expect to carry out this plan upon soils of an opposite character. We must not, however, reject it entirely, even for these soils, for there is a most valuable lesson to be learnt from it, which will *always* be of service, and that is the proof it gives of the fertilizing results of tillage operations. The Lois Weedon system may have its special districts for its successful or unsuccessful adoption, but the lesson we gather is of universal application—viz. that the culture of the soil is a most powerful and valuable cause of fertility.

We may, in conclusion, add a few remarks to what we have already stated as to the extent to which tillage operations are a substitute for manure. I have already shown that they are valuable promoters of fertility in all our soils, by the conversion of the dormant organic and inorganic matter they contain into fertilizing materials fitted to support and nourish vegetation, and that at the same time the soil is rendered more competent for absorbing from the atmosphere nitrogenized matter. These results, though evident upon all soils, will be more manifest upon soils already possessing a fertile character, and upon such soils tillage might to some extent supersede the use of manure; but upon inferior soils, although beneficial results will be evident, still the advantages will not be equal, and there will be greater necessity for the use of manure. Upon whatever soil the trial is made, the result must of necessity be regulated by the composition of the soil. If a soil is being cultivated which requires a free supply of the phosphates, and there is a natural deficiency in the soil, it is clear that the use of some phosphatic manure will be desirable, for no extent of tillage can compensate for the absence of such a body. It is just the same with the other ingredients required by our crops. If the soil is fertile it possesses these stores, and then culture brings them into use. It may, however, be said, cannot a chemical analysis of the soil at once indicate whether or not a soil is competent or not for the successful application of this system? I reply, it may be a safe guide in some cases, but the indications of nature, by the general products of the land, will be a safer guide in the majority of cases. There is, however, one important advantage which will result from tillage operations, and that is the storing away in the soil much of the ammonia of the atmosphere. This will take place upon all soils, but upon rich clays and loams more especially so. This is another powerful inducement for stirring and exposing the land—we have seen how valuable lime is in producing this result, and that it is an important co-operator in the action. Hence tillage operations in no way supersede the use of lime, but render its action more beneficial; neither does the cultivation of the land supersede the supply of manure for the crop when the land is deficient in one or more of the ingredients which the crop requires.

It is for these reasons, that whilst we value tillage operations as *most important* agencies for promoting the fertility of the land, we must not allow them to supersede the use of manure. We shall still find an economical use of our manures equally imperative and remunerative, and our higher appreciation of the great value of tillage operations will result in an increase of the average produce of our soils, rather than in depreciating the value of manures. Extremes are at all times dangerous. Whilst, therefore, we may more highly value tillage operations, and upon many soils realize thereby similar results to those attained from the use of ammoniacal manures, we must at the same time be cautious not to overlook the important results we obtain by the use of our various natural and artificial manures, and look to them as valuable promoters of fertility, which will always produce profitable results in proportion to the skill and discretion with which they may be prepared."

The foregoing considerations apply with principal force to what are commonly known as *strong* soils—loams, either stony or clayey, rather than to sandy soils. The latter much more than the former have need of actual *additions* made to them of fertilizing materials from the fact that they are more deficient in these. The addition of clay to sandy land acts both to improve its mechanical condition, making it more retentive of manure and moisture and by the addition of alumina, and is an economical and permanent improvement. Sandy lands, on the other hand, possess a natural advantage over *strong* soils in the ease with which agricultural operations are performed upon them; and this is so great as to compensate in large measure for the necessity of heavier or more frequent manuring.

By a beneficent arrangement of Providence, abundant supplies of vegetable matter are frequently found in close proximity to these poor sands, in the beds of muck or peat, which with some preparation and the addition of salt, lime, ashes and plaster is found to answer admirably to enrich them. In some of our counties, as in York and Cumberland, there are very considerable tracts of pine plains—sandy soils of little natural fertility, which may, I am fully persuaded, be cultivated with considerable profit, but which have hitherto availed only to furnish but a very scanty support to those tilling them.

I have been much interested in an attempt to improve a soil of this kind made by Eben Cobb, Esq., of Gray, in Cumberland county, and although the statement of his operations and of their results may be more fully given in the forthcoming report of the committee on farm improvements in that county, I cannot forbear to allude to their main features here.

Some years since Mr. Cobb bought of a non-resident who had inherited it, a tract of sandy plain—poor hungry land, like much around it, at a price to be fixed by the selectmen of the town. They, deeming it almost valueless, appraised it at $1.25 per acre, and Mr. Cobb accordingly paid $75 for sixty acres. In 1858 he broke up six acres, turning under the brakes, blueberry bushes, and other small growth as thoroughly as possible,—harrowed it several times during the season and got it tolerably subdued, the roots dried and killed, &c.;—cross-ploughed in the spring following, and applied compost prepared the previous season. This was made by hauling forty loads of muck a short distance (an inexhaustible supply being near at hand) and mixing it with a quantity of 'coal bottoms,'—from spots where charcoal had been formerly burnt on the land, and adding some ashes, gypsum and salt; then planted potatoes, corn and beans. All the operations up to this time cost $83. His crop consisted of 400 bushels of potatoes, 50 of corn and 5 of beans—worth that year $145. The same year he again mixed up forty loads of muck with ashes, &c., as before, and applied the following spring. The cost of the labor and the plaster, ashes, &c. bought for the purpose, for the second year's operations, amounted to $65, and the crop of 1860 was 700 bushels potatoes, 100 of corn and 9 of beans, estimated to be worth $300. When I saw it last (in August 1861) the crops, notwithstanding the drouth, were looking well, better than the average of crops in the State; and a half acre of buckwheat was decidedly the handsomest piece I had seen this year. It would appear that Mr. Cobb had inspired confidence in the minds of some as to the capabilities of such lands, as he informed me that he was lately offered $10 per acre for the lot, or $600 for what was appraised to him by disinterested parties at $75 a few years before. We have no reason to doubt the statements as above given, and they should encourage farmers occupying such soils to give his method, or some similar one, a fair trial.

S. L. GOODALE,
Secretary Board of Agriculture.

JANUARY, 1862.

[The necessity of allowing time and space for the reports of the scientific survey, which by the resolves authorizing the same, were directed to be printed in connection with this report, compels me to omit some papers which otherwise would have appeared above.]

PRELIMINARY REPORT

UPON THE

NATURAL HISTORY AND GEOLOGY

OF THE

STATE OF MAINE.

1861.

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INTRODUCTION.

To the Senate and House of Representatives:

Having been appointed by his Excellency the Governor, and the Secretary of the Board of Agriculture, to conduct a Scientific Survey of the State, in accordance with the legislative resolves in favor of such a survey, approved on the 16th day of March, 1861, we have the honor to present herewith a preliminary report of our investigations during the past season.

Our commissions, given upon the 23d day of May, authorized us to appoint assistants. As soon as possible, we commenced our operations in the field, some one or more of the party being constantly at work from the 1st of June to the 18th of October. The following is a list of all the persons employed in the organized corps of the survey:

EZEKIEL HOLMES of Winthrop, *Naturalist, &c.*
CHARLES H. HITCHCOCK of Amherst, Mass., *Geologist.*

Assistants:

George L. Goodale of Saco, *Botanist and Chemist.*
J. C. Houghton of Still River, Mass., *Mineralogist.*
A. S. Packard, Jr., of Brunswick, *Entomologist.*
C. B. Fuller of Portland, *Marine Zoologist.*

The following instructions were given us by the proper authorities in regard to our field work. "As an outline of operations for the present year, we recommend as follows:—that, commencing operations the 1st of June, you proceed, by rapid reconnoisances, to examine as much of the western and coast-lines of the State, as may be practicable, by the 10th of July,—more particularly with a view to ascertain the kind, breadth and direction of the geological formations which may be found, in order to establish a basis or border line of delineation of a geological map of the State; that, on or about July 10th, you repair to the more settled portions of Aroostook county, investigating its geology, natural history, agriculture and physical geography, with especial reference to the resources and capabilities of the public domain in that section; thence to the slate and iron regions of Piscataquis county, making similar investigations; thence to the Penobscot river and up the east branch thereof to its head waters; thence across to the Alleguash river or other tributary of the St. John, and down said river to Fort Kent—thus visiting a section hitherto unknown to scientific exploration."

In order to carry out the spirit of these instructions, we formed two parties—the one to explore the western border and a part of the coast-line, the other to explore the remainder of the coast-line and the eastern border of Aroostook county. Accordingly, Dr. Holmes, assisted by Mr. Goodale, explored the district between Winthrop and Farmington, to the western line of the State, then examined the country adjacent New Hampshire from Umbagog lake to Kittery point, and thence along the seaboard to the mouth of Kennebec river. This party devoted special attention to Zoology and Botany. The other party, consisting of C. H. Hitchcock and J. C. Houghton, explored the seaboard from Saco to Calais, making several excursions to the interior and to islands off the coast as occasion required; thence through the north part of Washington county to Houlton, Presque Isle, Ashland, and proceeded to Bangor by way of the Aroostook road. Here the two parties united in a joint exploration of the woods, leaving Bangor August 7. Dr. Holmes, C. H. Hitchcock, G. L. Goodale, A. S. Packard, Jr., with seven persons to assist as boatmen and hunters, went up the Penobscot river (east branch) down the Alleguash and St. John river to Woodstock, N. B., exploring the Natural History and Geology of the route as carefully as possible. Mr. Houghton, in company with G. L. Vose, Esq., of Boston, explored the iron and slate region of Piscataquis county, the country around Moosehead lake, and the west branch of Penobscot river, besides assisting Mr. Vose in making a careful measurement of the height of Mt. Katahdin. Thus, by these explorations, and by the use of valuable observations made by Dr. C. T. Jackson of Boston, published by the Legislature more than twenty years ago, we shall be able to form a tolerably correct general idea of the geological structure of the State, adequate both for a basis on which to delineate a general Geological Map, and to serve as a guide to future systematic and thorough explorations.

Owing to the short time allowed us in preparing this report, and the non-reception of our specimens from the wild lands, we shall be unable to give a complete history of our discoveries at present. We propose to divide this preliminary report into two parts. Part I will embrace General Reports upon the Natural History, Agriculture and Geology of the State; while Part II will be devoted to a Joint Special Report upon the Physical Geography, Agricultural Capacities, Geology, Botany and Zoology of the wild lands in the northern part of the State. The names of the authors of the different portions of the report will appear with what they have written.

We would take this opportunity to thank the citizens of all parts of the State for their hospitality and earnest efforts to promote our scientific explorations. We have met with no person who has not been interested in our work, and anxious to have the survey continued till a satisfactory examination has been made of every part of the State. Several gentlemen have volunteered to explore certain towns and districts for us; and others assisted us greatly by pointing out localities to us, often travelling twenty or thirty miles for the purpose. We are under special obligations to J. F.

Anderson of Windham, J. O. Robinson of Thomaston, Ezekiel Ross of Rockland, Messrs. Freeman, Sanborn and Dr. Porter of Cherryfield, Messrs. W. B. Smith, Charles A. Porter and Dr. Peabody of Machias, Col. J. C. Caldwell of East Machias, the Messrs. Chadbourne, and Jethro Brown of Perry, Dr. Swan of Calais, Hon. Shepard Cary of Houlton, Rev. M. R. Keep of Ashland, and W. S. Ripley of Paris.

PART I.

GENERAL REPORTS UPON THE NATURAL HISTORY AND GEOLOGY OF MAINE.

1861.

DR. HOLMES' REPORT.

To the Hon. Senate and House of
Representatives of the State of Maine:

GENTLEMEN:—In accordance with the requirements of the resolves authorizing and commencing a Scientific Survey of Maine, I herewith submit the following brief report of observations made during the summer past in the department of said survey committed to my charge, viz: Physical Geography of the State, Natural History, and Agriculture.

It must be evident to all, that this report must be merely preliminary to a final report which will be due at some future period, when the survey of the whole territory to be explored shall have been completed.

The careful exploration and critical and scientific examination of a tract of country covering more than thirty-one thousand square miles and a great part of those miles still covered with a dense forest which can be traversed advantageously only through its water channels by canoe or batteau, cannot be the work of a single summer nor a single year, however propitious may be the weather, or however favorable all other attendant circumstances and requirements may be. This "Report of Progress" must therefore be made up of apparently isolated facts and observations, which are to be more fully elaborated and collated when the whole ground shall have been gone over, and the work done.

Being directed and empowered by the appointing power (His Excellency the Governor, and the Secretary of the Board of Agriculture) to appoint such assistants as might be deemed requisite to the judicious prosecution of the work, I accordingly, with the concurrence and approval of my colleague in the survey, (Prof. C. H. Hitchcock,) selected the following named gentlemen for that purpose, viz:—George L. Goodale of Saco, Botanist; Alpheus S. Packard, Jr., of Brunswick, Entomologist, and C. B. Fuller of Portland, Marine Zoology; and I have great pleasure in saying that these gentlemen have, so far as the means and the time allotted us would allow, performed their respective duties with commendable and zealous fidelity. Their several reports, embodying the general results of their labors in the field, are herewith submitted.

Notes on the Physical Geography of Maine.

It will not do, in considering and examining the Physical Geography of Maine, or in other words, in giving an account and description of the *location* and *structure* and peculiar characteristics of its bays, shores or coast line, rivers, plains, mountains and valleys, to be wholly circumscribed and hedged in by conventional or territorial lines.

Nature has neither made nor observed any such lines, and in tracing in a geographical point of view, her operations and the connections of the several formations, of the country which exist in conformity with those operations, we must occasionally ignore territorial and political boundaries, and look upon the whole structure in all its parts and bearings.

Thus viewed, you will see that Maine constitutes no small part of an immense peninsula, formed by the waters of Lake Champlain—the river and gulf of St. Lawrence on the north and northeast, the waters of the Atlantic from the southern shores of said gulf to the mouth of Hudson river, on the southerly side, and the Hudson river on the westerly side.

Of this peninsula, Maine occupies a large part of the central southern side, embracing the principal shore of the vast bay enclosed between Cape Sable on the north, and Cape Cod on the south.

The natural grand divisions of this section of the peninsula in question—its sea-coast, rivers, mountains and plains, are remarkable for their broad developments, striking distinctive characteristics, and their influences on the climate, products and business facilities of their respective regions.

Sea-coast. The shore line, though in straight course, contained within a little more than four degrees of longitude, extends nevertheless in all its undulations and ramifications into the lesser bays, coves, creeks and river estuaries, keeping on the verge of high tide waters, over a stretch of more than three thousand miles. No State of the Union, and perhaps no single nation, can exhibit the same extent of sea-coast so well adapted to commercial purposes, or so magnificent, viewed either in regard to its shore and island scenery, or as to its valuable bays and safe moorings for shipping.

This coast trends, in a general direction, north-easterly and south-westerly. In this, it conforms to the "strike" or direction of the rock strata found throughout the State, and which are peculiarly well marked and distinct on the seaboard, making a firm and enduring barrier to the encroachments of the ocean, practically saying to every dash of its waves, "thus far shalt thou come but no farther."

The various species of rock formation, that line our coast, and form such a solid indestructible sea-wall, will be enumerated and more particularly described in Prof. Hitchcock's Report on the Geology of Maine. Suffice it here to say that in the more westerly portions they are made up of the several varieties of the slates, more particularly the micaceous and talcose schists, running sometimes into gneiss, granite and sienite. In the more easterly sections limestones and sandstones occur.

It has been a prevailing popular opinion that the "strike," or direction of our rock formations in a northeasterly and southwesterly course was, in some mysterious manner, brought about by the waters of our coast, inasmuch as the main course of our sea line is, as we before stated, the same.

The reverse must be the case. The direction of our rock strata governs the direction of our seaboard, and not the course of the sea line govern that.

The ocean, without doubt, once rolled deeply over them, and they then formed the bottom or foundation of it, and not its border.

By their rising from these lower depths to their present elevation, the sea retired to its present bed and its outline conformed to the direction of the rocks which they probably had when created.

Disintegrations, abrasions and breakings down of these rocks, have, in many instances taken place; forming thereby, coves and channels between the main land, and the reefs and the islands adjacent. In some places they are narrow and shoal, and in others wide and deep enough for whole navies to ride in with safety.

But these disintegrations and abrasions, though they have given rise to almost innumerable islands and capes, and headlands of different dimensions and forms, are, nevertheless, but partial, and of small extent, compared to the whole area of our maratime border, which still withstands the ceaseless action of the waters that press upon them in storm and in calm. Without desiring to trespass on the geologists departments, we may in reference to the structure of our coast be permitted to say, that this elevation of the present "dry land" took place at a period subsequent to the formation of the rocky strata which now characterize the geology, not only of this part, but of the whole peninsula of which Maine is a portion. This is made evident in a thousand instances of water action in places now far above where man has ever known it to flow. It is also made known by the deposit of fossil remains of marine productions. These remains are found, not only imbedded in the once plastic material of rocks of comparatively more recent origin than the primitive, or the metamorphic formations, and which will undoubtedly in most instances be found resting upon the latter, but are also found lying loosely on their surfaces on the bottom of the soil which covers them.

Whether there has been more than one upheaval, or several successive periods of the lifting powers, and whether there is not now going on, slowly but silently and surely a similar process, as is the case now on the coast of Sweden and Greenland, are questions to be decided by the geologists, but nevertheless of great moment in their results at least to the student of physical, as well as topographical geography.

In some locations, shells and remains of marine zoology have been found in places below the soil, but resting on rock surfaces high above the present bed of the ocean. If these remains are found to be of the same species as those now existing in the adjacent waters, would it not be a fair inference that their elevation is of rather recent date?

A long series of careful observations, aided by patient scientific research by individuals on the whole line, are required, in order to accumulate facts in answer to the above question. They are important to a clear and full understanding and explanation of many points in the Physical Geography of the State;—also as it regards the explanation of many appearances and the location of certain remains, the causes of which are now very obscure.

The solutions of many other questions which arise during an investigation of the subject in consideration are also dependent on future investigations of this character; such as the alleged changes in climate between that described, or intimated to exist by the earlier discoveries and voyages and the present times,—the causes of the difference of the rise and power of tides in different points from the Isle of Shoals to Canso—the difference in the range of temperature, both of the water and the atmosphere in various locations, almost in the same latitude*—the variations in the guage of snow and rains in places almost in the same neighborhood—the differences in the prevalence of fogs, in various points on our seaboard, and the influences which they all have upon our climate, soil, agricultural products, and the health and business prosperity of the inhabitants of the islands and the shores of the main land.

This is a work of time, and until a full and thorough research and investigation is had, and the discoveries of diligent and well-directed labor are all noted and collated, the Physical Geography of our coast cannot be fully elucidated and its peculiarities made known.

When this shall be done, and the topographical, or "coast survey," now being made by the United States Government, shall have been also completed, the Geology, Physical and Topographical Geography and Natural History of the sea-coast of Maine will form a document of rare interest to the inquiring mind, for its amount and diversity of facts and for its practical usefulness.

The observations and clearly ascertained facts bearing on these points will be reserved, subject to the control of the Executive until an accumulation of kindred knowledge embracing the whole line will warrant their publication in the final report.

MOUNTAINS. The Great Apalachian, or, as they are also called, the Alleghany Chain of Mountains, considered as having their principal rise in North Georgia and their northern spurs trending northeasterly along the continent, enter Maine on its western boundary. They are here called "White Hills," or the White Mountain range. Of these, Mt. Washington, one and a half mile, ? (7,920 feet,) is the loftiest peak, and is on the New Hampshire side of our line. This range continuing the north-easterly course fills a portion of the western section of Maine in Oxford county, with innumerable summits, many of them but little less in height to Mt. Washington and the adjacent peaks. These form a sort of irregularly triangular belt of elevations, having its base of perhaps fifty miles in extent on the west line of the State, and its terminus at Mars Hill on our eastern boundary, in Aroostook county. This chain or system of mountains has many interruptions or breaks. From the western border, eastward the elevations diminish in height until they approach the western bank of the Kennebec river in Somerset county when there occurs a break in the continuity of the chain. They there sink down into hills and broad swells from which are thrown up occasionally a lofty peak, as at Kineo, on the margin of Moosehead. In Piscataquis county they again assume the mountain size, especially on some of the northern tributaries of the Piscataquis river as instanced in Ebeme and Spencer mountains, and swelling higher and higher culminate at last in Katahdin, one mile (5,720 ft.) in height. These swells stretch along to the western side of the east branch of the Penobscot, when another break in their continuity occurs, and they become more separate and less and less lofty, occasionally throwing up a somewhat isolated summit like the "Sugar Loaf" and "Chace's mountain," and finally terminate in one of comparatively moderate height known as Mars Hill. Among the largest and highest of these on the west side are Speckled Mount or Mt. Matalluck in or near Grafton, Mt. Puzzle in Hanover, Mt. Blue in Avon, Mt. Abram in New Salem, and Saddleback and Bigelow in New Vineyard.

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* Careful observations made in Perry, in the eastern section of our coast, by Wm. D. Dana, Esq., and in Belfast, in the middle section, by George S. Bracket, Esq., from January to November, 1860, as published in the Secretary's Report for 1860, show a higher average temperature of 10 degrees in Perry, than in Belfast.

7920
6,293
1627

North of this belt there are no well defined and connected range of mountains. The general slope of the country on that side being toward the St. John river which drains the northerly sections of the State. On the south side the slope continues to the sea-coast and is drained by no less than six rivers of large size and extent besides several of minor length and dimensions. It is a little remarkable that several of the largest of these rivers take their rise on the northern side of the mountain bulk and have worked their way to the southern side and down the southern slope through gorges and narrow valleys of the range, and thence to the ocean.*

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* This proves that the alpine belt we spoke of is itself situate on the upper edge of the southern slope of our territory, and that although their summits are far above the slope of the plains below, their bases are on the southern side of the water shed in that region.

In some instances there seems to have been a shattering of the mountain barriers by some convulsion of nature apparently for the express purpose of letting out the pent up waters behind, in order that they might find their way through to the Atlantic far away below.

The structure of these mountains afford interesting lessons to the geologist and to the general student of nature, whether he is in pursuit of merely philosophical facts or sentimental emotions. Yet there is nevertheless a sameness in their rock formation. Granite and mica slate constitute the great bulk of their masses in the western section, through which extensive dikes of trap rock have often pushed their way. In the middle and eastern sections, talcose slate, clay slate, with beds of limestone at their base, or in the valleys and plains between them.

Their uses.—On a cursory view of this immense congregation of lofty and craggy summits, seen while standing on some of their highest tops, and looking around, it would seem to have been a mistake of creative power in thus piling together so much rugged earth in a form and condition to make it entirely waste land, and utterly unfit for any economic purpose in the support of human life and social comfort, and improvement. But God makes no mistakes. Rough and misshapen as are the most of these enormous piles of crag and ledge, they have important and indispensable uses in the great economy of animal as well as vegetable life, and to them, in the arrangements of Providence Maine owes an incalculable amount of the sources of her present prosperity and happiness and the continuance and increase of her prospective social power and strength. They are conducive to the health of her people, to the fertility of her valleys and her plains, to the regular flow of her rivers, to the rains which irrigate her crops in summer, and to the snows which protect the herbage of her fields and her meadows in winter. A country that has no mountains is, as a general thing, a dry and a barren one.

Possessing, as has been shewn, such an extensive stretch of seacoast as we have, from which are constantly arising vapors and exhalations into the atmosphere, it is fortunate that we have, midway of our territory, such effectual and ever acting condensers of these vapors, from whose tops the deposited moisture is collected in all its purity and sent down in millions of rills and rivulets to the reservoirs and lakes on their sides and at their feet; thus, day and night, in summer and winter, keeping the ceaseless and perpetual flow of rivers and streams that carry health, fertility and exuberance through all our borders. Strike these rude and uncomely mountains out of existence and your springs would fail, your rivers dry up, your lands would become parched, and your herbage wither and die. Nor are these the only uses of mountains in the economy of Nature. Their sides afford sites for extensive forests, the lumber of which is so indispensable to civilized life.

Long and long after the plains and moderate elevated hill sides have become cleared of their forest covering and changed to cultivated fields, or devoted to the purposes of pasturage, these steep sides will furnish fuel and lumber of all kinds for the uses of the people, and without which suffering and depopulation would be the result. As a secondary use they also furnish a home for the varieties of wild animals, so convenient, if not necessary to man for the production of furs and skins which he makes subservient to many of his wants, comforts, and even luxuries.

Further exploration and examination of this alpine region is requisite in order to ascertain their true height, their geological structure, and their character as it regards botanical and zoological products. Indications are, that many interesting specimens of alpine plants, as well as mineral and geological products will be found on and among them. Observations should also be made and experiments instituted to learn the effect they may have on the climate of their vicinity, and what variation if any they cause in the isothermal line, or line of equal temperature in summer and in winter. It is now an established fact that this line of equal temperature is by no means connected with, or dependent on the degrees of latitude, but is an exceedingly irregular one. Hence we find that the mean temperature of any location, in a given latitude, will not be sure to agree with another location in the same latitude 50 or an 100 miles west or east of it.

This variation is brought about by a great many different causes, and among them the presence of mountains play a very important part. Facts and observations in reference to this variation of the line of similar temperature are of great use in determining the precise character of climate, a knowledge of which is of so much importance in an agricultural point of view.

Some progress has been made in these researches, but the time of one brief season is only sufficient to make a beginning. It will require a series of barometrical, thermometrical and hygrometrical observations to enable one to draw sure and conclusive deductions which will be reliable, and therefore useful. in establishing truths in reference to the climatic influences which these elevations have on the region in which they exist.

LAKES AND RIVERS. No tract of country of the same extent on the continent is so well watered, or in other words is so well supplied with lakes and streams so distributed as to accommodate all sections, as Maine. There are five principal lake chains or systems, by which are meant, large lakes connected together by rivers or thoroughfares, and these to main channels which convey their accumulated waters to the ocean. These, beginning on the western boundary, are the Umbagog series, consisting of Umbagog, Wallakenabagog, Argwassuck and Moosilla Maguntic. These are drained by the Androscoggin river. The Moosehead series. These are drained by the Kennebec river. The Penobscot series, consisting of the Chesuncook and its surrounding lakes, on the west branch of the Penobscot—Alleguash, Chamberlain and others of the east branch. The Sebois and others connected with it, still further east, but flowing into the east branch of the Penobscot. The St. John Lakes, including the Eagle Lakes and the St. Croix Lakes in the southeasterly section, drained by the St. Croix river. In addition to these, there are a great number of others of less extent in every county, familiarly called "ponds," from which flow streams of less volume, but nevertheless of great use as affording mill sites for almost every neighborhood.

The lakes of the larger series are found principally in the mountain regions of the State, more of them on the northerly than on the southern side of them, and it is a little remarkable that their waters work their way through the breaks and vallies of their ranges to the southerly side, and thence leaving the high elevations, run at right angles to them down the southern slopes to the ocean.

None of these lakes have been surveyed with a view of ascertaing their exact area, average depths and volume. Some of them, as Moosehead, are of sufficient depth to allow of steamboat navigation. Few of the larger series have as yet been broken in upon by settlers. Their shores and adjacent lands have been and still are the harvest fields for the lumbermen and their waters afford them facilities for getting in supplies to the operators and for floating their lumber to the mills and markets below. They are also, in the appropriate seasons of the year, places of resort for the hunter, and the fisherman, and sportsmen generally, who are in pursuit of game, recreation and health. All of them are remarkable for the purity of their waters and many of them for the beauty and picturesque scenery which surround and of which they make the leading feature.

The largest of these is Moosehead in a somewhat central portion of the State, and is estimated to be fifty miles in length and from ten to fifteen miles in breadth.

Umbagog on the western border is estimated to be from fifteen to twenty miles in length and about ten in width. Chesuncook, near Mt. Katahdin, twenty by from three to five miles.

This is a meagre account of our series of lakes; but until more extended and thorough examination of them with reference to their geographical position and extent and their capacity as reservoirs and sources of our rivers, and a scientific investigation as to their natural history and their influence and bearing on the climatic condition of the surrounding country directly and remoter regions indirectly can be had, little more can be said of them. They must remain a broad and fertile field for future research by the geographer, the naturalist, and general philosopher.

Until this field has been fully explored their immense value and importance to the strength and prosperity of the State cannot be fully known and realized.

Rivers. The great extent of our lake series gives rise to as many rivers which traverse the State in about equally divided sections, and thus afford communication from the interior to the ocean, giving with their tributaries more widely distributed water power than can be found in any other section of the Union of an equal number of square miles. Not a tenth part of the water power, by which we mean eligible mill sites, is as yet occupied.

The larger rivers of Maine are the Saco, the Androscoggin, the Kennebec, the Penobscot, the St. Croix, and the upper St. John. A vast number of streams, either tributary to some one of these or flowing independently of them, are scattered over other territory, affording all the uses and conveniences incident to such streams in the interior and estuaries and harbors at their mouths on the seaboard.

The time allotted for exploration during the past season, gave an opportunity for but brief examinations of a small section of the upper parts of the Saco river and the Androscoggin. The Penobscot was traversed from Oldtown to Chamberlain Lake.

This examination, hasty and imperfect as it was, proves incontestibly the proof of the theory I have elsewhere advanced, that the upper sections at least, of each of our largest class of rivers was formerly a connected chain of lakes. That these waters then washed very much higher, shores and banks than they do at the present day—that they at some period long back in the ages gone by broke through the barriers that held them in as lakes and settling down to their present bed, constitute the rivers as we now find them.

Commencing on our western border, the first river of the larger class, is the Saco. This takes it rise on the White hills, principally on the declivity of Mount Washington, but is constantly fed by the little mountain rivulets. Its general course through the notch and gorges of the mountains is southerly, until it reaches the southern side of the mountain belt above Fryeburg, when it sweeps round in a very serpentine but general east course to the east margin of this town, when it takes a general southeastern direction which it continues to the Saco bay, where its waters mingle with the ocean. At Fryeburg and lower part of Conway, it once formed a large lake and in that condition received the particles of the abrasions and washings of the mountains through which its waters came which were deposited on the bottom and shores of the quiescent lake. The barriers which held in the lake state in the neighborhood of Hiram, at length gave way and the waters settling down to their present bed left the extensive intervals and plains or alluvial land in and around Fryeburg. A part of this interval at the present day often at times of extensive rains and freshets becomes for a short time a lake and in that situation additional alluvial matter becomes deposited, thereby gradually raising the height of the interval and continuing its fertility. This takes place as often as the accumulations of water in the mountains above are too great to find a corresponding egress through the narrower channel below at Hiram or vicinity. Below this last named place, the river flowing in most cases across the "strike" of the rock formations through which it passes, receives checks and obstructions, thereby causing rapids and falls, the most of which are now taken up for mill sites and employed in the various industrial pursuits of life.

The last grand obstruction of this kind is at Saco and its opposite shore (Biddeford) where it has been made the subject of consummate engineering skill and is thereby employed as the motive power of some of the best manufacturing establishments in the world.

The Saco river was early taken possession of by the first settlers of the country. Its banks and the banks of its tributaries were rich in stores of pine and other lumber which for nearly two centuries made it the scene of extensive lumber operations. The legends and history of these and the concomitant incidents of pioneer life connected with them, would make, could they be written, a volume full of romantic and thrilling interest.

Further and more extensive observations are required before a full and exact description of the physical geography of the Saco and the basin it drains can be given.

Androscoggin. The next principal river east of the Saco, is the Androscoggin. This takes its rise not far from the Canada line and the head lands that divide the waters of the Chaudiere, Kennebec tributaries and the Androscoggin. It passes southwesterly, expanding in its course into the lakes Moosila Maguntic, Argwason, Molechunkamunk, Wallakenabagog and Umbagog. From this last lake it passes out on its northwest quarter, at first westerly and then southerly, in a sluggish quiet manner until it comes to Erol, in New Hampshire. Here it meets with obstructions and forms a fall which has been taken up for mill sites. It continues to flow in a southerly direction until it reaches Shelburne, when it sweeps round the base of the mountains easterly to the easterly line of Livermore, when it again curves southeasterly, which general course it holds until it unites with the Kennebec river at Merrymeeting bay.

The Androscoggin from the time it meets with its first obstruction at Erol has a difficult and troubled pathway, and has in consequence more rapids, falls and cataracts, than any other river of its size and extent in Maine. It also has along its banks at certain sections of its course, some splendid intervals as well as swells of upland of the first quality. Evidences are abundant to prove that it was once, in the space at least from Shelburne to East Livermore, what a part of it is now at Umbagog and above, a connected chain of lakes, separated at certain places by obstructions which formed natural dams and held its waters at higher level, until they gave way and furnished them a more free passage, as we now find them. It was while in this lake state, that the splendid intervals that we now see as we pass along were formed. Our reasons for this belief are the following:

1. These intervals or bottom lands, are alluvial deposits. The material of which they are composed was deposited while the water was in a quiescent state, and not while it was in motion. They therefore formed the bottom of lakes or ponds.

2. These intervals, or bottom lands, are not continuous—that is, they do not continue all along the banks, but are found located in sections of more or less magnitude and at different distances from each other, and these separations are formed by the highlands coming down nearer to the river than they do in the region of the intervals. Hence, in passing up the river from Livermore Falls to Shelburne, N. H., whenever you pass over a portion of the road where the highlands close in toward the river, you may prophesy that you will ere long come to a tract of interval land. This you will find to be the case in passing from Livermore Falls to Jay. You find the highlands coming more or less near to the banks on the Livermore and Jay side, for a while, and on passing through them you come upon the splendid intervals of Jay point, formerly owned, if not now, by the Hollands and others. The cause of their formation at this locality was, in the first place, a valley or layer opening between the mountains, giving space for a lake, and in the next place, the obstruction, for a long time, of the river, by the highlands below, thereby forming a lake at the place referred to. Here when the current was at rest, the fine particles of earthy matter gathered, and suspended in the water in their course, were deposited at the bottom and by their accumulations, formed what are now the beautiful farms which are so productive to their owners and give such agreeable contrast to the scenery of the neighborhood around them. On a reverse principle we account for there being comparatively less amount of alluvial and more diluvial land or "drift" in that portion of the river below Livermore Falls, than above. The Androscoggin, at Jay, had worked itself to the southerly side of the mountain chain, through which it had passed from the upper part of Gilead in this State, in an easterly direction, and thereby nearly out of them. Consequently it come into a less elevated and more open country. Finding less obstruction here, at the southerly margin of the hills than further east, it was turned

almost square about, in a southerly direction, and spread itself over a large extent, depositing, while in motion, as it passed along, the sands and heavier gravels and probably, while the ice prevailed, heavy boulders, thus forming sand bars and islands, &c. &c. which now constitute the swells and ridges and irregular curves that form the surface of that part of the country. It may be asked, if that were the case, why do we not find remains of shells and aquatic animals in the rocks and ledges near by? Because they belong to that epoch or period which geologists call "*azoic,*" (*without life,*) a period before animal life, even of the lowest order, had commenced—a period perhaps as early as when "the evening and the morning were the fourth day,"* and no living creature had yet started from the hand of the Almighty. And yet the movements, the abrasions and the doings of the elements then in action, stand recorded upon the eternal hills in characters so legible that "he who runs may read."

So full of obstructions is the channel of the Androscoggin that but a small part of it can be said to be navigable. Indeed it may be said that none of it, for although vessels of considerable size have been built at the foot of the falls at Brunswick and floated down to its junction of the Kennebec while light, they seldom if ever return up. This river has on some of its falls as at Brunswick and Lewiston, large manufacturing establishments for manufacturing lumber, cotton, wool, &c. Other very eligible rapids and falls as at East Livermore and Rumford have as yet hardly been encroached upon, while the power there running at waste is equal in volume and efficiency to any of its privileges yet improved.

Before completing the examination of the upper section of the Androscoggin, the time arrived when we were ordered to the expedition up the east branch of the Penobscot and through the wild lands on that route. Remarks and observations on this last named river will therefore be given in the report on that part of the survey.

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* Geologists and most Divines are now satisfied that the six days mentioned in regard to the creation, in Genesis, are not our astronomical days of 24 hours each, but long periods of time, in which God wrought out by the operations of his own laws and power the several changes which took place from chaos to the creation of man. To Him "a thousand years are as one day."

ZOOLOGY OF MAINE.

BIRDS.

I here give a catalogue of the birds that have been identified as belonging to, or found in different sections of Maine. In the arrangement I have followed the modern system, grouping them into seven Grand or General Divisions. The generic and specific descriptions of these birds will form a part of the final report. Naturalists have, somewhat unwisely I think, made too many technical or scientific names and thereby loaded the department of Ornithology with synonymes. In this catalogue I have put down first the name by which they are described by the older pioneers of American Ornithology, such as Wilson and Audubon, and lastly the name adopted by Baird in his recent works. I here take pleasure in acknowledging the kind and very essential aid I have received in this department from George A. Boardman, Esq., of Milltown, whose researches in the ornithology of his section of country and the fine collection he has made, make him good authority in Maine and New Brunswick Ornithology. That section is more rich in birds of the Sixth and Seventh Divisions (Grallatores and Anatores) than the western portions of our territory.

DIVISION I.—RAPTORES, (*Robbers.*)

Common Name.	*Technical or Scientific Name.*
Golden Eagle.	Aquila Canadensis, *L.*
White Headed Eagle.	Haliaetus leucocephalus, *L.*
Fish Hawk or Osprey.	Falco halietus, *L.*, *Wilson.*
	Pandion Carolinensis, *Gm.*
Great Horned Owl.	Bubo Virginianus, *Gm.*
Mottled Owl.	Strix asio, *L.*
	Scops asio, *L.*
Short Eared Owl.	Brachyotis palustris americanus, *Bona.*
	Brachyotis Cassinii, *Brewer.*
Long Eared Owl.	Otus Americanus, *Bona.*
	Otus Wilsonianus, *Lesson.*
Great Brown Owl.	Strix acclamator, *Bartram.*
	Syrnium cinereum, *Gm.*

RAPTORES, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Barred Owl.	Syrnium nebulosum, *Forster.*
Tengmalmis Owl.	Strix Tengmalmi, *Gm.*
	Nyctale Richardsoni, *Bonap.*
Saw-whet Owl.	Strix passerina, *L.*
	Nyctale Acadica, *Gm.*
Snowy Owl.	Strix nyctea, *L.*, Nyctea nivea, *Daudin.*
Hawk Owl.	Strix ulula, *L.*, Surnia ulula, *L.*
Duck Hawk or Bigfooted Hawk.	Falco peregrinatus, *Wilson.*
	Falco unatum, *Bona.*
Pigeon Hawk.	Falco temerarius, *Aud.*
	Falco columbarius, *L.*
Falcon.	Falco Islandicus, *Gm.*
Sparrow Hawk.	Falco sparverius, *L.*
Goshawk.	Falco atricapillus, *Wilson.*
	Astur atricapillus, *Wilson.*
Sharp Shinned Hawk.	Falco velox, *Wilson.*
	Accipiter fuscus, *Gm.*
Red Tailed Hawk.	Buteo borealis, *Gm.*
Red Shouldered Hawk.	Buteo lineatus, *Gm.*
Broad Winged Hawk.	Buteo Pennsylvanicus, *Wilson.*
Marsh Hawk.	Falco uliginosus, *Wilson.*
	Circus Hudsonius, *Linn.*

DIVISION II.—INCESSORES, (*Perchers.*)

Robin.	Turdus migratorius, *L.*
Red Start.	Sylvia pinus, *Wilson.*
	Dendroica pinus, *Baird.*
Wood Pewee.	Muscicapa virens, *L.*
	Contopus virens, *Cabanis.*
Pewee, Phebe bird.	Muscicapa fusca, *Gm.*
	Sayornis fuscus, *Baird.*
Great Crested Flycatcher.	Muscicapa crinita, *L.*
	Myarchus crinitus, *Cabanis.*
Kingbird.	Muscicapa tyranus, *Wilson.*
	Tyrannus Carolinensis, *Baird.*
Kingfisher.	Alcedo alcyon, *L.*
	Ceryle alcyon, *Boie.*

INCESSORES, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Chimney Swallow.	Hirundo pelasgia, *L.*
	Chaetura pelasgia, *Stephens.*
Barn Swallow.	Hirundo Americana, *Wilson.*
	Hirundo horreorum, *Barton.*
Tree Swallow.	Hirundo viridis, *Wilson.*
	Hirundo bicolor, *Vieillot.*
Bank Swallow.	Hirundo riparia, *L.*
	Cotyle riparia, *Boie.*
Moon fronted Swallow; Cliff, do.	Hirundo lunifrons, *Say.*
Martin Bird.	Hirundo purpurea, *L.*
	Progne purpurea, *Boie.*
Night Hawk.	Caprimulgus Americanus, *Wilson.*
	Chordeiles popetue, *Baird.*
Whippoorwill.	Caprimulgus vociferus, *Wilson.*
	Antrosomus vociferus, *Bona.*
Humming Bird.	Trochilus colubris, *L.*
Hermit Thrush.	Turdus solitarius, *Wilson.*
	Turdus Pallasii, *Cabanis.*
Olive Back Thrush.	Turdus Swainsonii, *Cabanis.*
	Turdus olivaceus, *Giraud.*
Golden Crown Thrush.	Turdus aurocapillus, *Wilson.*
	Seiurus aurocapillus, *Swainson.*
Water Thrush.	Turdus aquaticus, *Wilson.*
	Seiurus Noveboracencis, *Nuttall.*
Tit Lark.	Alauda rufa, *Wilson.*
	Anthus Ludovicianus, *Licht.*
Canada Fly Catcher.	Musicapa Canadensis, *L.*
	Myodioctes Canadensis, *Aud.*
Wilson's Blackcap.	Muscicapa pusilla, *Wilson.*
	Myodioctes pusillus, *Bona.*
Yellow Rump Warbler.	Sylvia coronata, *Wilson.*
	Dendroica coronata, *Gray.*
Black Poll Warbler.	Sylvia striata, *Latham.*
	Dendroica striata, *Baird.*
Bay Breasted Warbler.	Sylvia castanea, *Wilson.*
	Dendroica castanea, *Baird.*
Black Throated Green Warbler.	Sylvia virens, *Wilson.*
	Dendroica virens, *Baird.*

INCESSORES, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Cape May Warbler.	Sylvia maratima, *Wilson.*
	Dendroica tigrina, *Baird.*
Blackburnian Warbler.	Sylvia parus, *Wilson.*
	Dendroica Blackburniæ, *Baird.*
Yellow Poll Warbler.	Sylvia aestiva, *Latham.*
	Dendroica aestiva, *Baird.*
Red Poll Warbler.	Sylvia petechia, *Wilson.*
	Dendroica palmarum, *Baird.*
Winter Wren.	Sylvia troglodytes, *Wilson.*
	Troglodytes hyemalis, *Vieillot.*
American Gold Crowned Wren.	Sylvia regulus, *Wilson.*
	Regulus satrapa, *Licht.*
Ruby Crown Wren.	Sylvia calendula, *L.*
	Regulus calendula, *Licht.*
Blue Bird.	Motacilla sialis, *L.*
	Sialia sialis, *Baird.*
Brown Creeper.	Certhia Americana, *Bonap.*
Black and White Creeper.	Certhia maculata, *Wilson.*
	Mniotilta varia, *Vieillot.*
Black Cap Titmouse.	Parus atricapillus, *L.*
Hudson's Bay Tit.	Parus Hudsonicus, *Forster.*
Red Eyed Vireo.	Muscicapa olivaca, *Wilson.*
	Vireo olivaceus, *Vieill.*
Solitary Vireo.	Vireo solitarius, *Vieillot.*
Cedar Bird.	Ampelis Americana, *Wilson.*
	Ampelis cedrorum, *Baird.*
Bohemian Chatterer.	Ampelis garrulus, *L.*
Shrike or Butcher Bird.	Lanius excubitor, *Forster.*
	Collyrio borealis, *Baird.*
Scarlet Tanager.	Tanagra rubra, *L.*
	Pyranga rubra, *Vieillot.*
Cat Bird.	Turdus lividus, *Wilson.*
	Mimus Carolinensis, *Gray.*
White Bellied Nut Hatch.	Sitta Carolinensis, *Gm.*
Red Bellied Nut Hatch.	Sitta Canadensis, *L.*
Pine Grosbeak.	Pyrrhula enucleator, *Aud.*
	Pinicola Canadensis, *Cabanis.*
Blue Grosbeak.	Loxia coerulea, *L.*
	Guiraca coerulea, *Swainson.*

Incessores, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Rose Breasted Grosbeak.	Loxia rosea, *Wilson.*
	Guiraca Ludoviciana, *Swainson.*
Purple Finch.	Fringilla purpurea, *Gm.*
	Carpodacus purpureus, *Gray.*
Yellow Bird.	Fringilla tristis, *L.*
	Chrisomitis tristis, *Bona.*
Pine Finch.	Fringilla pinus, *Wilson.*
	Chrysomitris pinus, *Bona.*
Red Cross Bill.	Curvirostra Americana, *Wilson.*
White Winged Cross Bill.	Curvirostra leucoptera, *Wilson.*
Lesser Red Poll.	Fringilla linaria, *L.*
	Aegiothus linaria, *Cabanis.*
Bobolink.	Emberiza oryzivora, *L.*
	Dolichonyx oryzivorus, *Swainson.*
Red Wing Black Bird.	Sturnus praedatorius, *Wilson.*
	Aegilaius Phoeniceus, *Vieillot.*
Crow Black Bird.	Gracula quiscala, *L.*
	Quiscalus versicolor, *Vieillot.*
Rusty Black Bird.	Gracula ferruginea, *Wilson.*
	Scolecophagus ferrugineus, *Sw'n.*
Orchard Oriole.	Oriolus mutatus, *Wilson.*
	Icterus spurius, *Bona.*
Baltimore Oriole.	Oriolus Baltimore, *L.*
	Icterus Baltimore, *Daudin.*
Raven.	Corvus corax, *Wilson.*
	Corvus carnivorus, *Bartram.*
Crow.	Corvus corone, *Wilson.*
	Corvus Americanus, *Aud.*
Blue Jay.	Corvus cristatus, *L.*
	Cyanurus cristatus, *Swainson.*
Canada Jay.	Corvus Canadensis, *L.*
	Perisoreus Canadensis, *Bona.*
Snow Bunting.	Emberiza nivalis, *L.*
	Plectrophanes nivalis, *Meyer.*
Lapland Longspur.	Plectrophanes lapponicus, *Selby.*
Shore Lark, Sky Lark.	Alauda cornuta, *Wilson.*
	Eremophila cornuta, *Boie.*
Baywing Bunting.	Emberiza graminea, *Gm.*
	Poocaetes gramineus, *Baird.*

INCESSORES, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
White Throated Sparrow.	Fringilla albicollis, *Gm.* Zonotrichia albicollis, *Bona.*
Chip Bird or Little Blue Snow Bird.	Fringilla socialis, *Wilson.* Spizella socialis, *Bona.*
Fox Colored Sparrow.	Fringilla rufa, *Wilson.* Passerella iliaca, *Swainson.*
Tree Sparrow.	Fringilla arborea, *Wilson.* Spizella monticola, *Baird.*
Swamp Sparrow.	Fringilla palustris, *Wilson.* Melospiza palustris, *Baird.*
Yellow Winged Sparrow.	Fringilla passerina, *Wilson.* Coturniculus passerinus, *Bona.*
Savannah Sparrow.	Fringilla Savanna, *Wilson.* Passerculus Savanna, *Bona.*
Yellow Bill Cuckoo.	Cuculus Americanus, *L.* Coccygus Americanus, *Bona.*
Black Cuckoo.	Cuculus erythophthalmus, *Wilson.* Coccygus erythophthalmus, *Bona.*

DIVISION III.—SCANSORES, (*Climbers.*)

Pileated or Black Woodcock.	Picus pileatus, *L.* Hylatomus pileatus, *Baird.*
Golden Winged Woodpecker.	Picus auratus, *L.* Colaptes auratus, *Swainson.*
Yellow Bellied Woodpecker.	Centurus flaviventris, *Swainson.*
Black Back three toed, do.	Picus arcticus, *Aud.* Picoides arcticus, *Gray.*
Downy Woodpecker.	Picus pubescens, *L.*
Hairy Woodpecker.	Picus villosus, *L.*

DIVISION IV.—GYRATORES, (*Whirlers.*)

Wild Pigeon.	Columba migratoria, *L.* Ectopistes migratoria, *Swainson.*
Longtailed or Carolina Dove.	Columba Carolinensis, *L.* Zenaidura Carolinensis, *Bona.*

Division V.—Rasores, (*Scratchers.*)

Common Name.	*Technical or Scientific Name.*
Ruffed Grouse or Birch Partridge.	Tetrao umbellus, *L.*
	Bonasa umbellus, *Stephens.*
Canada Grouse or Spruce do.	Tetrao Canadensis, *L.*

Division VI.—Grallatores, (*Waders.*)

Blue Heron or Crane.	Ardea herodias, *L.*
Stake Driver or Bittern.	Ardea minor, *Wilson.*
	Botaurus lentiginosus, *Stephens.*
Green Heron.	Ardea virescens, *L.*
	Butorides virescens, *Bona.*
Night Heron or Qua Bird.	Ardea nycticorax, *Wilson.*
	Nyctiardea Gardeni, *Baird.*
Golden Plover.	Charadrius pluvialis, *Wilson.*
	Charadrius Virginicus, *Borck.*
Kildeer Plover.	Charadrius vociferus, *L.*
	Aegialitis vociferus, *Cassin.*
Piping Plover.	Charadrius melodus, *Ord.*
	Aegialitis melodus, *Cab.*
Black Bellied Plover.	Charadrius apricarius, *Wilson.*
	Squatarola Helvetica, *L.*
Ring Plover.	Tringa hiaticula, *Wilson.*
	Aegialites semipalmatus, *Bona.*
Ash Colored Sand Piper.	Tringa canutus.
Red Backed Sand Piper.	Tringa alpina, *L.*
Semi Palmated Sand Piper.	Tringa semipalmata, *Wilson.*
	Ereunetes petrificatus, *Illiger.*
Little Sand Piper.	Tringa pusilla, *Wilson.*
	Tringa Wilsonii, *Nuttall.*
Pectoral Sand Piper.	Tringa pectoralis, *Bona.*
	Tringa maculata, *Vieill.*
Purple Sand Piper.	Tringa maritima, *Brunnich.*
Sanderling Sandpiper.	Charadrius calidris, *L.*
	Calidris arenaria, *Illiger.*
Spotted Sandpiper.	Tringa macularia, *L.*
	Tringoides macularius, *Gray.*
Solitary Sandpiper.	Tringa solitaria, *Wilson.*
	Rhyacophilus solitarius, *Bona.*

GRALLATORES, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Willet.	Scolopax semipalmatus, *Gm.* Symphemia semipalmata, *Hartl'b.*
Yellow Legs.	Scolopax flavipes, *Gm.* Gambetta flavipes, *Bona.*
Tell Tale.	Scolopax vociferus, *Wilson.* Gambetta melanoleuca, *Bona.*
Hudsonian Godwit.	Limosa Hudsonica, *Latham.*
Curlew Sandpiper.	Tringa subarquata, *Guld.*
American Snipe.	Scolopax Wilsonii, *Temm.* Gallinago Wilsonii, *Bonap.*
Red Breasted Snipe.	Scolopax Noveboracensis, *Gm.* Macrorhamphus griseus, *Leach.*
Woodcock.	Scolopax minor, *Gm.* Philohela minor, *Gray.*
Long Bill Curlew.	Numenius longirostris, *Wilson.*
Hudsonian Curlew.	Scolopax borealis, *Gm.* Numenius Hudsonicus, *Latham.*
Esquimaux Curlew.	Numenius borealis, *Latham.*
Turnstone Curlew.	Tringa interpres, *L.* Strepsilas interpres, *Ill.*
Ruff.	Tringa pugnax, *L.* Philomachus pugnax, *Gray.*
Sora or Common Rail.	Rallus Carolinus, *L.* Porzana Carolina, *Vieillot.*
Coot or Mud Hen.	Fulica atra, *Wilson.* Fulica Americana, *Gm.*

DIVISION VII.—ANATORES, (*Swimmers.*)

Canada Goose.	Anas Canadensis, *L.* Bernicla Canadensis, *Boie.*
Brant Goose.	Anas bernicla *L.* Bernicla brenta, *Stephens.*
Mallard.	Anas boschas, *L.*
Dusky Duck.	Anas obscura, *Gm.*
Pintail Duck.	Anas acuta, *L.* Dafila acuta, *Jenyns.*
Green Wing Teal.	Anas crecca, *Forster.* Nettion Carolinensis, *Baird.*

ANATORES, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Blue Wing Teal.	Anas discors, *L.* Querquedula discors, *Stephens.*
Shoveler.	Anas clypeata, *L.* Spatula clypeata, *Boie.*
Gray Duck or Gadwell.	Anas strepera, *L.* Chaulelasmus streperus, *Gray.*
Widgeon.	Anas Americana, *Gm.* Mareca Americana, *Stephens.*
Wood Duck, Summer Duck.	Anas sponsa, *L.* Aix sponsa, *Boie.*
Scaup or Black Head.	Anas marila, *L.* Fulix marila, *Baird.*
Ring Neck.	Anas fuligula, *Wilson.* Fulix collaris, *Baird.*
Whistler or Golden Eye.	Anas clangula, *Forster.* Bucephala Americana, *Baird.*
Buffle Headed.	Anas albeola, *L.* Bucephala albeola, *Baird.*
Harlequin.	Anas histrionica, *L.* Histrionicus torquatus, *Bona.*
Old Squaw or Longtailed Duck.	Anas glacialis, *L.* Harelda glacialis, *Leach.*
American Scoter.	Anas nigra, *Wilson.* Oidemia Americana, *Swainson.*
Eider Duck.	Anas mollissima, *L.* Somateria mollissima, *Leach.*
Goosander or Sheldrake.	Mergus merganser, *Wilson.* Mergus Americanus, *Cassin.*
Red Breasted Sheldrake.	Mergus serrator, *L.*
Hooded Sheldrake or Merganser.	Mergus cucullatus, *L.* Lophodytes cucullatus, *Reich.*
Stormy Petrel or Mother Cary Chicken.	Procellaria pelagica, *L.* Thalassidroma pelagica, *Vigors.*
Leach's Petrel.	Thalassidroma Leachii, *Bona.*
Great Shear Water.	Puffinus cinereus, *Bona.* Puffinus major, *Faber.*
Manks Shear Water.	Puffinus anglorum, *Temm.*

Anatores, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Gannet.	Sula bassana, *Briss.*
Wilson's Tern.	Sterna Wilsoni, *Bonap.*
Bonaparte Gull.	Larus Bonapartei, *Rich.* Chroicocephalus Philadelphia, [*Lawrence.*
Black Headed Gull.	Chroicocephalus atricilla, *L.*
Kittiwake Gull.	Larus tridactylus, *L.* Rissa tridactylus, *Bona.*
Herring Gull.	Larus argentatus, *Brunnich.*
Black Back Gull.	Larus marinus, *L.*
American Gull.	Larus Delawarensis, *Ord.*
Arctic Jager.	Lestris Richardsonii, *Aud.* Stercorarius parasiticus, *Temm.*
Cormorant.	Phalacrocorax carbo, *Bona.* Graculus carbo, *Gray.*
Loon.	Colymbus glacialis, *L.* Colymbus torquatus, *Brunnich.*
Red Throat Loon.	Colymbus septentrionalis, *L.*
Red Neck Grebe.	Podiceps rubricollis, *Lath.* Podiceps griseigena, *Gray.*
Pied Bill Grebe.	Podiceps Carolinensis, *Lath.* Podilymbus podiceps, *Lawrence.*
Razor Bill Auk.	Alca torda, *L.*
Little Auk.	Mergulus alle, *L.*
Puffin or Sea Parrot.	Mormon arctica, *Illiger.*
Murre or Guillemot.	Uria grylle, *L.*
White Winged Guillemot.	Uria troile, *Bona.* Uria ringvia, *Brunnich.*

MAMMALS.

Order I.—Mausupiata.

None in Maine.

Order II.—Cheiroptera, (*Bats.*)

Common Name.	*Technical or Scientific Name.*
Common Bat.	Vespertilio Noveboracensis, *Gm.*
Hoary Bat.	Vespertilio pruinosus, *Say.*

ORDER III.—INSECTIVORA, (*Insect Eaters.*)

Common Name.	*Technical or Scientific Name.*
Mole Shrew.	Blarina talpoides, *Gray.*
Starnosed Mole.	Condylura cristata, *Ill.*

ORDER IV.—CARNIVORA, (*Flesh Eaters.*)

Panther or Catamount.	Felis concolor, *L.*
Loup Cervier (Loo Servee.)	Lynx Canadensis, *Raf.*
Grey Wolf.	Canis occidentalis, *Rich.*
Red Fox.	Vulpes fulvus, *Rich.*
Silver Fox, Black Fox.	Vulpes argentatus, (var.)
Fisher Cat.	Mustela Pennantii, *Erxl.*
Sable, Pine Marten.	Mustela Americana, *Turton.*
Brown Weasel.	Putorius Cicognanii.
Ermine.	Putorius Richardsonii, *Bona.*
Black Mink.	Putorius nigrescens, *Aud.*
Otter.	Lutra Canadensis, *Sab.*
Sea Otter. (?)	Enhydra marina, *Fleming.*
Skunk.	Mephitis mephitica, *Baird.*
Raccoon.	Procyon lotor, *Storr.*
Black Bear.	Ursus Americanus, *Pallas.*
Common Seal.	Phoca vitulina, *Linn.*
Hooded Seal.	Stemmatopus cristatus, *Gm.*

ORDER V.—RODENTIA, (*Gnawers.*)

Red Squirrel.	Sciurus Hudsonius, *Pallas.*
Gray Squirrel.	Sciurus migratorius, *Aud.*
	Sciurus cinereus, *Linn.*
Black Squirrel.	Sciurus nigra, (var.)
Flying Squirrel.	Pteromys volucella, *Cuv.*
Northern do.,	Pteromys Hudsonius, *Fischer.*
Striped Squirrel, (Chip Munk.)	Tamias striatus.
Woodchuck.	Arctomys monax, *Gm.*
Beaver.	Castor Canadensis, *Kuhl.*
Jumping Mouse.	Jaculus Hudsonius, *Wagner.*
Brown Rat.	Mus decumanus, *Pallas.*
Common House Mouse.	Mus musculus, *L.*
Whitefooted Mouse.	Hesperomys leucopus, *Wagner.*
Hamster Mouse.	Hesperomys myoides, *Baird.*

RODENTIA, (*Continued.*)

Common Name.	*Technical or Scientific Name.*
Redbacked Mouse.	Arvicola Gapperi, *Vigors.*
Muskrat.	Fiber zibethicus, *Cuv.*
Porcupine.	Erethizon dorsatus, *F. Cuv.*
White Rabbit.	Lepus Americanus, *Erxl.*

ORDER VI.—RUMINANTIA, (*Ruminant Animals.*)

Moose.	Alce Americanus, *Jardine.*
Caribou.	Rangifer caribou, *Aud. & Bach.*
Deer.	Cervus Virginianus, *Boddaert.*

ORDER VII.—CETACEA, (*Air-breathing, warm-blooded Sea Animals.*)

Right Whale.	Balaena mysticaetus, *Linn.*
Sperm Whale.*	Physeter macrocephalus, [*Lacepede.*
Beaked Rorqual.	Rorqualus rostratus, *Fabr.*
Northern Rorqual.	Rorqualus borealis, *Knox.*
Black Fish.	Globicephalus melas, *Lesson.*
Porpoise.	Phocaena communis, *Cuv.*
Grampus.	Phocaena orca, (*Fabr.*) *DeKay.*

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* These whales are seldom seen now in our waters, but in the early settlement of the coast they were quite common.

BOTANICAL REPORT.

To Ezekiel Holmes, *M. D.*,
Naturalist to the Scientific Survey:

Sir:—I have the honor to present herewith a brief catalogue of those plants, detected by me during this summer, which have not as yet been credited to Maine in editions of our Standard New England Botany—Gray's Manual. In the catalogue, I have also noticed those, which, considered rare in the Manual, have been found growing common in Maine. And, at your suggestion, I have made notes of plants detected infrequently to which Dr. Gray has given an extensive range.

It gives me much pleasure to add the names of some plants recently discovered by acute botanists in Maine, and which they have been so kind as to communicate to me. The list is also enlarged by some plants noticed lately by botanists of other States, and of which specimens have been placed at my disposal.

Let me add, sir, that several plants were noticed and collected by me this summer, which I have little doubt will prove to be new species; but sufficient time has not yet elapsed to obtain the scientific sanction of our eminent American botanists in regard to their specific characteristics or previous nomenclature. Therefore they are omitted in this report, as I prefer to wait until I receive communications concerning specimens forwarded to them.

In several instances I have been able to define the range of some species whose limit in our State was very imperfectly known.

Anemone parviflora, *Mx.*—Occurs plentifully on the rocky banks of the St. John.

Anemone Pennsylvanica, *L.*—Common in Eastern Aroostook Co. on the banks of rivers and brooks.

Adlumia cirrhosa, *Raf.*—Found in Aroostook county.

Subularia aquatica, *L.*—Ponds in Waterford where it was first found by Nuttall.

Hudsonia ericoides, *L.—Bog-pond* in Fryeburg.

Silene inflata, *Smith.*—On the Alleguash river.

Alsine Grœnlandica, *Fenzl.*—York Cliffs; St. John.

Sagina nodosa, *Fenzl.*—At Wells, Mr. Blake; Cape Elizabeth, Mr. Sprague. Prof. Tuckerman noticed at this last locality a Sagina with a glandular, viscid stem, which he considers a well marked variety of S. nodosa. Also found by me on the main St. John.

Claytonia Virginica, *L.*—Common in Aroostook county.

Acer dasycarpum, *Ehrhart.*—Banks of Androscoggin.

Crotallaria sagittalis, *L.*—Near York beach.

Astragalus Robbinsii, *Gray.*—Main St. John.

Astragalus alpinus, *L.*—Near Fort Kent.

Oxytropis Lamberti, var. d., *Torrey and Gray's Flora*, p. 339.—On the banks of the St. John. Dr. Gray thinks this plant may be O. Uralensis, DC.

Hedysarum boreale, *Nutt.*—Main St. John.

Lathyrus maritimus, *B.*—Main St. John.

Prunus maritima, *Wang.*—York. Wells.

Prunus pumila, *L.*—Penobscot, East Branch; called by the lumbermen, "Beach plum" and "Sand cherry."

Potentilla Pennsylvanica, *L.*—On Northern Penobscot and Grand Lakes; also at Cape Elizabeth, Mr. Sprague, Prof. Tuckerman; at York cliff.

Potentilla fruticosa, *L.*—On rocky banks of Northern rivers.

Epilobium alpinum, *L.*—Mt. Katahdin (rare.)

Hippuris vulgaris, *L.*—Often in the still water ("Logans") of the Penobscot, East Branch.

Ribes rubrum, *L.*—"Basin" at Katahdin.

Saxifraga rivularis, *L.*, var. comosa.—Detected near the "chimney" at Katahdin, by Mr. Blake in 1856. This plant is new to our New England Flora—the typical form, only, occurring at the White Mountains.

Aralia quinquefolia, *Gray.*—Aroostook county.

Viburnum pauciflorum, *Pylaie.*—Base of Katahdin.

Galium verum, *L.*—Near Portland.

Nardosmia palmata, *Hooker.*—Westbrook, Judge Howard; Fryeburg, Mr. Weston; Aroostook county, sent by Rev. Mr. Keep; Waterford; Alleguash river; near Fort Fairfield.

Bellis perennis, *Mx.*—Escaped from gardens in Saco and near Portland.

Solidago Virga-aurea, *L.* var. humilis.—Mt. Katahdin, by Rev. Mr. Blake.

Rudbeckia hirta, *L.*—Noticed in various parts of Washington county—"introduced within two years."

Tanacetum Huronense, *Nutt.*—On banks of main St. John; on Alleguash, St. Francis and Madawaska rivers. Not detected south of Seven Isles.

Artemisia Canadensis, *Mx.*—St. John.

Artemisia caudata, *Mx.*—Wells, Rev. Mr. Blake; also at York and Biddeford.

Arnica mollis, *Hooker.*—Katahdin, rare.

Nabalus racemosus, *Hooker.*—St. Francis river.

Lobelia Kalmii, *L.*—Eastern Aroostook county.

Rhododendron maximum, *L.*—Standish, near Sebago lake.

Plantago Virginica, *L.*—York cliffs.

Castilleia septentrionalis, *Lindley.*—St. Francis and St. John.

Rhinanthus Crista-Galli, *L.*—Lubec and Eastport, Mr. Houghton.

Mertensia maritima, *Don.*—Plentifully at York beach; also at Biddeford.

Halenia deflexa, *Grieseb.*—Near Katahdin; not seen by any of our party above Seboois river.

Polygonum Tataricum, *L.*—Cultivated on the banks of the St. John, by the French who call it "rough buckwheat." Having escaped from fields it grows plentifully in the woods of upper St. John. As it is new to our New England Manuals, a description is herewith annexed.

P. Tataricum, *L.*—Ls. cordate-sagittate; stem unarmed; seeds with unequal angles and toothed.

This grain constitutes the great staple of the food of the Acadians of the river, and appears to ripen the fruit early enough to escape the September frosts.

Euphorbia esula, *L.*—A troublesome weed near Perry.

Myrica cerifera, *L.*—On the banks of the St. John.

Salix Uva-ursi, *Pursh.*—Mt. Katahdin, Rev. Mr. Blake. Also found on "Traveller."

Pinus Banksiana, *Lam.*—Noticed by me at two places only—the Traveller Mt. and on an island in Grand Lake. Lumbermen call it a scarce tree in Northern Maine. It is named by them "Lake" and "Rock-pine."

Platanthera Hookeri, *Lindl.*—In Aroostook county.

Calypso borealis, *Salisb.*—Rev. Mr. Chickering collected fine specimens in a swamp near Oldtown.

Iris Virginica, *L.*—Near Chamberlain Lake.

Clintonia borealis, *Raf.*—Near Katahdin, and northward.

Allium Schœnoprasum, *L.*—On St. John.

Tofieldia glutinosa, *Willd.*—Common on the banks of St. John, St. Francis and Fish rivers.

Luzula arcuata, *Meyer.*—Mt. Katahdin.

Juncus militaris, *Bigelow.*—Near Chamberlain Lake, thirty miles north of Katahdin.

Scirpus fluviatilis, *Gray.*—Near a pond in Perry.

Carex Norvegica, *L.*—Rev. Mr. Blake detected this species near Wells beach.

Vilfa cuspidata, *Torrey in. Hooker's Fl. Bor. Am.*—Near Grand Falls on the St. John. Dr. Gray very kindly determined this species.

Triticum caninum, *L.*—Prof. Tuckerman collected this plant at Cape Elizabeth; also the following species new to our Flora:

Triticum junceum, *L.*

Woodwardia angustifolia, *Smith*—Acton and Brownfield.

Aspidium aculeatum, var. Braunii.—Rocks near Katahdin; also near Mt. Lunksoos.

Selaginella apus, *Sprengl.*—Kittery, in meadows.

Thanks to the kind assistance of Rev. Mr. Blake, now of Gilmanton, N. H., Rev. Mr. Chute of Boston, Rev. J. W. Chickering, Jr., formerly of Portland, Mr. G. W. Weston of Fryeburg, Mr. A. S. Packard, Jr., of Brunswick, and very many others, I am able after this season's work to prepare a tolerably full catalogue of the plants of Maine. But you, sir, and the Geologist of the survey, thought it advisable to defer the publication of such a list till further survey shall have increased the number of species known to exist in the State. From the hasty, but highly satisfactory search made thus in connection with the geological explorers, I am convinced that there exists in Maine, particularly in the northern part and on the extreme eastern coast, a highly interesting field for botanical investigation. And since the survey of this season has developed the fact of a flora in Aroostook East, differing from that of the North of Maine or South of the State, it becomes a matter of much interest to determine the limits of the more "western plants"—for, where these plants occur, we find the mild climate and fertile soil which renders Aroostook county such a desirable home for a farmer; in fact, the defining of such limits will serve to mark the line between the fertility of the Eastern part of the county and the colder timber land of the Northern and Western portions.

One word in relation to the specimens collected by me this summer and autumn. They were of course hastily prepared under the pressure of a daily task besides their collection, and during protracted journeys. Therefore they are not all such specimens as please a botanist, but they serve sufficiently well for the determination of species. I have deposited for the present in the rooms of the Portland Society of Natural History, the following;

Plants of Oxford county, 622 species.

Plants of York county, 409 species; of course some are duplicates of Oxford.

Plants of Katahdin and vicinity, 123 species.

Plants of Northern and Eastern Maine, 800 species. Exclusive of Cryptogamia, there are 912 species and 9,000 specimens.

Yours respectfully,

G. L. GOODALE,

Botanist to the Survey.

ENTOMOLOGICAL REPORT

ON THE ARMY WORM AND GRAIN APHIS.

BY A. S. PACKARD, JR., BRUNSWICK.

The summer of 1861 will be long remembered by agriculturists by the injury their crops received from the sudden and unprecedenced appearance of a caterpillar which destroyed the leaves and heads of every sort of grain; and of a species of *Aphis* or *plant-louse* that gathered in immense numbers on the ears of the grain that had been left untouched by the army worm, sucking out the sap of the ear, and thus lessening very materially its weight; or if in many cases not doing as much damage as this, causing much apprehension and anxiety to farmers generally.

No one in this State, at least, we believe, has ever heard of these two insects before this year, though very probably they have been living among us, unnoticed from their rarity, for some years. We regret that we could not personally have observed the habits of these insects, but are obliged to depend on communications to agricultural papers. We are especially indebted to Mr. Sanborn of the Massachusetts State Museum, for much information about, and specimens of the army worm (its chrysalis and moth,) and two of its parasites; to S. L. Goodale, Saco, and to C. A. Shurtleff of Brookline, Mass., for similar favors. Much interesting material is given in "Insects injurious to Vegetation, in Illinois: by B. D. Walsh."

ARMY WORM.

The most injurious of these two insects is the larva of the *Leucania unipuncta*, one of a family of night-flying moths that embraces an immense number of species. The genus *Leucana* has a spindle-shaped body, a robust thorax, with a distinct collar just behind the head which above is triangular, carrying near the base, the thread-like antennæ or feelers, which are about two-thirds the length of the wings. Two stout palpi, with a slender tip project from the under side of the head, from each side of the hollow sucking-tube used to suck the sweets of flowers, but which at rest is rolled up between the palpi and rendered almost invisible by the thick-set, long hair-like scales that cover the head. A little behind the front margin of the thorax are placed the wings; the forward pair narrow and oblong, arched slightly at the apex, and just below, the outer oblique edge bulges out slightly. The outer edge or that farthest out from the insertion of the wing is in this genus two or three times as wide as the base. In the middle of the forewing is a vein that runs out very prominent to just where it divides into three lesser branches; on this point in the species described below is a conspicuous white dot which gives it its name, *unipunctata*.

The hind wings are short, broad and thin, just reaching out to the outer edge of the forewing. There is a slight notch near the middle of the outer edge, and the inner edge or that most parallel to the abdomen is fringed with quite long hairy scales, that run into the pale fringe of the outer edge, which is always paler and broader than that of the forewings. Both wings are much paler beneath, and do not show the markings of the upper side. When the moth is at rest the hind wings are laid upon the abdomen and partially folded, so that the forewings over lap one another above them, like a roof. Thus folded, the ends of the wings are not much wider than the thorax.

The abdomen tapers rather rapidly, ending in a pencil of hairs. The second and third joints of the legs are much thickened, the last joints armed with minute spines, four of which are largest on the third joint.

Characters like these show moths of this genus to be strong and swift on the wing. In meadows and grass lands when disturbed they dart suddenly up from under our feet and plunge into covert very quickly again. In the evening they fly in great numbers into open windows, attracted by the light within.

Most of our Maine species of Leucana have light colored wings, with dark streaks and dots, but the *unipunctata* is larger and darker colored. Its prevailing hues are rusty grayish-brown, sprinkled or peppered sparsely with black scales. The upper part of the head, the front part of the thorax or collar and front margin of the forewing are of a lighter shade. Between the front margin of the forewing and the vein or raised line reaching out to the white spot in the centre, is a rusty patch. Just beyond, about half way between the white dot and the outer edge is a row of about ten black dots situated on the veins, running towards the apex of the wing, but the last three are deflected at a right angle inwards and up to the front margin, while a dark line starts from the corner or curve in the line of dots and proceeds to the upper angle or apex of the wing. The little veins of the outer edge are silvery, and between them in a row next to the fringe can just be seen little black dots.

The hind wings are pearly smoke colored, darker towards the outer edge, with a central spot of the same color which can be seen on the under side.

Beneath, the moth is a light pearly gray. The forewings are clouded in the middle, with a dark spot on the front margin one fourth of the way from the tip. The forewings are rather more pointed in this species than the other. The body measures nearly an inch long, and the wings expand a little over an inch and one-half.

Having satisfactorily made out the *species* of which the army worm is the larva, we can proceed to tell what we know of its habits and transformations; after this, how to guard against its increase; and what is done in nature to keep it within its proper bounds by means of external enemies and parasites.

The eggs are most probably laid near the roots of our wild grasses, such as timothy and red top. They are in most species of this genus laid in large numbers, perhaps over a hundred by each moth in certain tracts of land about the middle of June, probably in the New England States, because about that time the moth flies. In Illinois, the moth lays its eggs in April and May, from four to six weeks earlier than in the eastern States; so the larva appears earlier; the moths lay their eggs for a second brood in June and July, while here the moth again appearing in October, most probably then lays eggs which hatch out in the spring, though we have not positive proof to that effect.

Larva. About the last of June, these eggs placed in local and confined tracts of grass land hatch their young larvæ which for four weeks or thereabout feed incessantly till full fed on the grass around the place of their birth, straying off as their forage is eaten up to fresh pastures. But meanwhile birds and insect enemies thin out their numbers; a few change to chrysalids pupæ—a few moths appear in circumscribed spots and are very rarely heard of. The entomologist considers the species a rarity and so very interesting—such we may consider the ordinary history of this moth. But now, in 1861, the moth becomes *very interesting* in a new sense when it consumes millions of dollars worth of grain. From some hidden cause the caterpillar swarms in immense numbers, still in circumscribed spots, visiting only certain towns, or certain fields in those towns.

We first hear of the army worm when it is about an inch long. Its previous history, the changes the larva undergoes from its hatching, how many times its casts its skin are not known; but it has eaten up all the grass around its place of birth, and in myriads is pushing out its columns after forage. The mature larva is about an inch and a half long. Its cylindrical body, divided into thirteen rings becomes more contracted and wrinkled at each end, and is sparsely covered with short hairs. The head is covered by a net work of confluent spots, while along the middle of the face run two lines diverging at each end. A light colored waved line just above the legs is succeeded by a dark one, then a light one edged with two thread-like lines; while the upper part is dark with an interrupted white thread running exactly through the middle of the back. The prolegs, ten in number, are marked on their outer middle and on their tip with black. Beneath, the caterpillar is of a livid green.

Its name is suggestive of the regular, trained way, in which myriads of these caterpillars march together in long deep columns, side by side, steadily over every obstacle, wherever their instinct leads them. Unlike the cut worm which moves by night, singly, from field to field, and secrete themselves by daytime amid the roots of the plants they attack, the army worm feeds in the forenoon and evening, generally; scattered over fields of grain or grass, either eating the leaves, or cutting off the heads and letting it fall on the ground. They will thus cut across the field, wantonly mowing off the heads of the grain. In this way, in Plymouth county, Mass., they destroyed an acre and a half of wheat in one night, and then attacked a corn field in the same way.

All young insects, or those in the larval stage, are exceedingly voracious; they eat surprising quantities of food. When these army worms are shut up together without food, they will quickly devour each other. We give some extracts to illustrate what we have said, from the New England Farmer and Boston Cultivator. A writer in Danvers, Mass., says: "They were seen in great numbers through the entire field of several acres, climbing up the stalks of the barley, eating the blades and cutting off the heads of the grain. The day after these worms were discovered, the barley was mowed in order to preserve it, when they dropped to the ground, throwing themselves into a coil, a habit of the insect when disturbed. Many of them soon commenced a march for the neighboring fields and gardens, while others blindly pushed forward a column across the highways over a stone wall, where they were crushed by travellers on the road. But the main body marched to the adjoining gardens and enclosures, where the proprietors were waiting to receive them in their entrenchments, which had been thrown up a foot wide, and two feet deep. The worms, as they fell in their advance into the trenches, were assailed in various ways by eager combatants, some spreading over them lime, tar or ashes, while others resorted vigorously to pounding them. In this way, countless numbers of them were destroyed. The rear guard, composed principally of those of smaller growth, kept in the field, where they were picked up by a troop of fifty young red-winged blackbirds. I also noticed the robins feeding on these vermin." Again: "In adjoining lots they were commencing their devastation upon the corn, turnips, cabbages, weeds and grass. They leave the grass ground completely clean and white, so that it has the appearance of having been scorched in the sun. The cabbage and turnips they destroy by eating the tender parts of the plants, while they attack the corn by descending the spindle and concealing themselves in large numbers among the leaves where the corn is to make its appearance. Corn thus attacked, looks wilted and drooping. In some hills, the stalks were stripped of all their leaves. There were no worms upon the potato tops, though they have killed all the grass to the borders of the field."

In the Southern and Western States, the army worm appears in numbers in certain years, and then are rare for some years. In southern Illinois in 1818 or 1820, they were more numerous than in 1861. In 1842, they were about as numerous as in 1861. In 1856, they occurred in small numbers. So in other years; while between these seasons, no one saw them. Thus it is well known and established in the south and west, so that when it appeared in

New York and New England, the past summer, there were thought to be two species of army worms. But the moths from different sections of the East and West, have been compared and found to be the same. Dr. Fitch, also, has shown that "worms *in armies*," and "black worms," referred to by writers as occurring in New York and New England in 1743, 1770, 1790, and 1817, with habits like those of the army worm of 1861, must be the same species. Mr. Sanborn assures me that he took the moth in 1855 near Boston; and has found the larva under stones in grass plots. On Mr. Clark's farm at Carratunk, near the Forks of the Kennebec, the army worm did a great deal of damage to the barley, in all destroying forty acres of grain. This was about the middle of August, and soon after the caterpillars entered the ground to transform. Their ravages were especially noticed, according to the "Maine Farmer" in North Berwick, Union, Bangor, Ellsworth, and one or two other towns. Mr. Goodale informs us that on Mr. Joseph Clark's farm in Waldoborough, the worm was found both in wheat and barley fields, though less on the wheat which was riper. The leaves were consumed, while the heads were not much eaten. Many of the heads were cut off and had fallen upon the ground, while others were cut just enough to hang over. Mr. Goodale collected numbers of the worm on the 14th of August, and fed them till on the 20th, all but one had gone into the earth. September 7th, these millars appeared, and so several each day until the 16th. I have never taken this species in Maine, until I met the worm in Bangor, Aug. 2d, in a yard a few rods from the Bangor House, and nearly full fed Aug. 13th, in a field of barley in Mattamiscontis, on the Penobscot above Bangor. It was not seen on farms above this point on that river, or on the Allegash or St. John, so far as I could ascertain, while the wheat Aphis was abundant on every farm I visited on those rivers. Whether the army worm made its appearance for the first time in Maine in 1861, can be only probable. In Massachusetts, it was first noticed the first of July, in Maine a month later, where it became generally prevalent.

The Pupa. The middle of August, the larva, full fed, descends into the earth a few inches, and there, by constant wriggling of its body and the excretion of a stickey fluid, constructs a rough earthen cocoon; or often it merely constructs a rude cell of dry grass just below the surface, and there in a day or two, probably, as is the case with most moths, the mahogany-colored pupa, nearly an inch long, with wing covers reaching to the last third of the body, with two spines slightly curved in, situated on the last segment; emerges from the outer larva-skin or mask, and lying there ten or fifteen days till the tissues of the future moth shall be formed and hardened, discloses the imago or moth the last of August. No doubt there are two broods of moths during one season. But the question now is, whether the moths lay their eggs now upon the grass stalks to develop the young during the winter, or the race is kept alive by the hybernation of the pupa, or of the moth. All these modes are probable, though it is most probable that the pupa hybernates, disclosing the moth early in the summer as most lepidopterous pupæ do. This is not so much a practical question as has been thought, for if lands are burnt over in the dead of the year where these eggs or pupæ or moths abound, which is the best remedy we can apply to keep off or kill off this moth, the fire will certainly kill the chrysalids just below the roots of the grass, as it surely will the eggs on the stalks, or the moth nestling among them.

Remedies. As we said just above, the best thing that can be done is to burn in the dead of the year the meadows and low grass lands. Tracts of land thus burnt over last spring escaped the army worm in the summer, while farms near by suffered from the incursions of worms from the unburnt grass lands around.

Ditching, or making a deep trench with steep or undermining sides, especially efficacious in sandy soils, will do much towards keeping them out of fields of grain. People have also laid tar in the bottom of ditches, laid trains of guano and made bonfires in them. By turning fowl and hogs into fields just as the caterpillar is going into the earth to perpate, great numbers can be destroyed, and the hogs and hens will grow fat on them.

Enemies. How birds of different kinds feed on these caterpillars has been noticed. Then there are night birds that catch the moths as they fly. Both the larva and moth are exposed on every hand to the attacks of other insects, such as the dragon flies, which are continually on the wing, especially over low lands. A large purple beetle with rows of golden spots on its wing-covers, the *calosoma calidum*, which is very common in grass lands, either running about after their prey, or lying on the watch in their holes among the grass, makes great havoc among the army worm, and not only the beetle, but its larva, which is more voracious if possible.

But undoubtedly the grand check that nature has imposed upon the too great increase of caterpillars, are their

PARASITES,

or those ichneumon flies belonging to the great order *Hymenoptera*, and a species of *Diptera*, or the true flies, which lay their eggs on or inside of the caterpillar. The young hatching out feeds on the fatty tissues of the caterpillar, which lives along just time enough for the parasite within to come to maturity. The larger ichneumons only live singly in the body of the caterpillar, while as many as a hundred of the minute species have been seen to emerge from the dead larva skin, their cocoons placed side by side within.

We first notice a large species which Mr. Shurtleff raised from the army worm between the first and middle of September.

1. *Ophion purgatus, Say*. This genus of ichneumons has a slender body, with long filiform antennæ. The thorax above oval, and as wide as the head. The legs are long and slender; but the most apparent character is the long compressed abdomen which much arched or sickle-shaped is attached to the body by a slender peduncle. The end of the abdomen is cut off obliquely inwards below. The ovipositor is scarcely to be seen, which in most ichneumons is very long; and here we see the adaptation of this organ to the habits of the species. Instead of piercing the body of the victim and depositing the egg at the bottom of the wound, the ophion merely lays its egg on the skin of the caterpillar. The egg is bean-shaped and attached by a pedicle to the skin. When the footless grub is hatched, it does not entirely leave the egg-case, but the last joints of its body remain attached to the shell, while it reaches out over and with its sharp jaw-pieces gnaws into the side of the caterpillar. Some ophions are parasitic on other ichneumons, just as are the species of *Chalcis* mentioned below.

This species, common in Maine, is of a pale reddish horn color. The head is yellow, pale testaceous at the base of the antennæ. The large prominent eyes black. Three smaller black simple eyes are arranged in a triangle above, between the compound eyes. The rest of the body, especially the hind part of the thorax, and the joints and under side of the abdomen and legs beneath are covered by a bloom of minute lighter colored hairs which have their origin in microscopic punctures. On the middle of the thorax above a little darker; and behind a yellowish tint. Next the insertion of the abdomen the thorax is thickly and plainly punctate.

Same color beneath, except the first three joints of the abdomen which are touched with yellow, and the lower side is generally darker.

The veins of the wings are dark; the thickened cell on the front margin of the fore wings, and the adjacent veins as well as the horny triangular pieces in the cell below, the outer of which is much the smallest, are pale horn color.

Body nearly an inch long. Expanse of wings 12½ tenths.

Mr. Walsh of Illinois has discovered three other ichneumons, descriptions of which we take from his pamphlet.

2. *Mesochorus vitreus*, *Walsh*. "Male, general color light rufous. Eyes and ocelli black, antennæ fuscous except towards the base. Upper surface of thorax in the larger specimen fuscous; intermediate and posterior tibiæ with spurs equal to one-fourth their length; posterior knees slightly dusky; tips of posterior tibiæ distinctly dusky. Wings hyaline, nervures and stigma dusky. Abdomen viewed in profile, curves considerably, especially at base, and is quite narrow, except towards the tip, where it expands suddenly. The abdomen of the male is appendiculated. It is of a translucent yellowish white in its central one-third; the remaining two-thirds piceous black, with a distinct yellowish narrow annulus at the base of the third joint. Appendiculum of abdomen composed of two extremely fine setæ, thickened at their base, whose length slightly exceeds the extreme width of the abdomen.

The female differs in the head, being from the mouth upwards piceous. The thorax and peetus are piceous black. Ovipositor, which is dusky, slightly exceeds in length the width of the abdomen. Body .08–.03 inch long."

3. *Pezomachus minimus*, *Walsh*. This genus is wingless like the neuters of ants, except that their antennæ are not elbowed like those of ants.

"Male, piceous. Eyes black, antennæ black, except towards the base, where they are light rufous. Legs rufous, hind legs a little dusky. Abdomen narrowed; second and sometimes third joint annulate with rufous at tip. The female differs in the thorax, being almost invariably rufous, and in the first three abdominal joints being generally entirely rufous, with a piceous annulus at at the base of the third, though sometimes absent. The abdomen is also fuller and wider. Ovipositor dusky, equal in length to the width of the abdomen. Body .07 to .1 inch long."

The cocoons symmetrically arranged side by side, and enveloped in floss, are found in the dead skins of the army worm. A minute ichneumon, *Chalcis albifrous, Walsh,* was bred from the cocoons of the Pezomachus.

4. *Microgaster militaris, Walsh,* is another army worm parasite. "Head black; palpi whitish; antennæ, fuscous above, light brown beneath towards the base. Thorax black, polished, with very minute punctures. Nervures and stigma of the wing fuscous. Legs light rufous, posterior pair with knees and tips of tibiæ fuscous. Abdomen black, glabrous, highly polished. Ovipositor not exserted. Length of body .07 inch."

Two parasites live in this microgaster, *Hockeria perpulchra* and *Glyphe viridescens,* belonging to the chalcid family of ichneumons. He also says: "We now know that of 145 ichneumon flies, promiscuously taken, that had depredated on the army worm, 27 or only 18 per cent. perished by *chalcis flies.*"

5. *Ichneumon leucaniæ, Fitch.* Dr. Fitch has given an account of another ichneumon. He says: "This parasite resembles a small wasp, nearly half an inch long, of a bright rust red color, its wings smoky, its breast black, and also the middle of its back, where is a small bright sulphur-yellow spot, which is the scutel. The antennæ have a milk-white band on their middle, below which band they are rush-red, and above it black. There are two narrow bands also on the back of the abdomen, placed on the fourth or fifth joints, and the slender peduncle of the abdomen is also black." Mr. Sanborn has raised this same species, as also another ichneumon, which we describe.

6. *Ichneumon species.* Ichneumons of this genus are rather slender bodied; the abdomen long-oval. Wings not much longer than the slender antennæ, which in turn are a little more than one-half the length of the whole body. The legs and joints of the feet are also slender. The ovipositor of the female is not apparent: her eggs are pedunculated, having a general likeness to those of the genus Ophion.

The species before us is black and yellow. Head: face square, yellow; a dark line borders the base of the antennæ which are rusty, the first joint yellow, and the ends dusky. Head behind the antennæ black. Thorax black; above on its first joint, or prothorax, a yellow transverse elliptical spot. On the second joint which carries the fore wings are two yellow stripes forking towards the head. Scutellum yellow; another transverse elliptical yellow spot behind. Third joint of thorax yellow above, black beneath, Legs: first and second pair yellow, reddish above on first joint. Third pair black at base; second joint yellow; third, or femur, black; fourth, or tibia, black at tip. Tarsi, or toes marked with black.

The elbowed abdomen black at base, the elbow yellow. The next three yellow joints with a narrow black strip on the front edge, the hinder edge of the ring tinged with reddish. Last three rings black.

Our last parasite is a fly, or species of the *Tachina* family, that Mr. Shurtleff and Sanborn have both raised from the army worm, and I find it to be identical with the species that attacks the worm in the west.

7. *Senometopia militaris, Walsh.* This genus resembles in form, our common house fly. The thorax is usually striped longitudinally, and the whole body covered with large hairs. It flies low in sunny spots in woods, with a loud buzzing noise. We copy Mr. Walsh's description, and select some interesting information he gives us about its habits: "Length, .25 to .40 inch; the females not exceeding .30 inch. Face silvery, with lateral black hairs only on the cheeks, at the top of which is a black bristle. Front golden olive, with a black central stripe, and lateral black convergent hairs. Occiput, dusky. Labium, brown, with yellowish hair. Maxipalps, rufous. Eyes, cinnamon brown, covered with very short dense whitish hair. Antennæ, two basal joints, black, with black hairs; third joint flattened, dusky, and from two and a half to three times the length of the second joint; seta, black. The entire hinder part of the head covered with dense whitish hair. Thorax glabrous, blueish gray and lighter at the sides, with four irregular black vittæ, and black hairs and bristles. Scutel, reddish brown, whitish behind, glabrous, with black hairs and bristles. Pectus, black, glabrous, with hairs and lateral bristles; legs, black, hairy; thighs, dark cinereous beneath; purvilli, cinereous. Wings, hyaline; nervures, brownish; alulæ, opaque greenish white. Abdomen, first joint black; second and third, opalescent in the middle, with black and gray, and at the sides with rufous and gray; last joint, rufous, slightly opalescent at base with gray; all with black hairs and lateral bristles.

Beneath, the first joint is black; the others, black marginal with rufous, all with black hairs. In the male, the space between the eyes at the occiput is one-seventh of the transverse diameter of the head; in the female, it is one-fourth."

Some pupa cases of this fly before me, are a little more than a quarter-inch long, cylindrical, rounded at each end. The last segment barely distinguishable, has two little flattened plates that were the breathing pores in the larva. The two first segments are partially split off, and ruptured across the end, where the fly burst out. The fly appeared the 20th of September.

"The eggs," Mr. Walsh says, "are much the shape and color of those of the flesh fly. The fly fastens its eggs by an insoluble cement on the upper surface of the two or three first rings of the body. Instinct appears to teach the mother fly that if she places her eggs further back, the little maggots, as they hatch out and begin to penetrate the flesh, will be felt by the victim and seized by its powerful jaws, as I have seen wood-feeding caterpillars seize, and worry like a dog, ants that attacked them."

Mr. Walsh had fifty or sixty worms, of which all but two had their eggs, from one to six in number fastened on their upper side. From these, he had fifty-four Tachinas and two moths. "Now these army worms averaged about three eggs apiece, and consequently two-thirds of the eggs of the Tachina must have perished without arriving at maturity."

"My Tachina eggs, so far as I noticed, did not hatch till the larva had gone under ground; but from information received from Mr. Emery, I have reason to believe that, under certain circumstances, this, or an allied species, hatches out above ground, adhering externally, and 'growing rapidly, while its victim decreases in size.' They uniformly devoured the larva before it transformed into the pupa state. The time for the entire transformation of such as I experimented upon from egg to fly, was from fifteen to nineteen days." * * * "Jefferson Russell, an intelligent farmer, had repeatedly, on damp cloudy mornings, watched a large, bluish green fly, about the size of a blow-fly, attacking the army worm, and depositing its eggs on the shoulders of the victim, as he ascertained by a double lens. As they were attacked, the army worms kept dropping to the ground and gathering in clusters, or hiding under clods, until finally the wheat on which they occurred, was entirely free from them."

Summary. The army worm moth appears in June; about a month later, or the last of July and first of August, the caterpillars appear. A fortnight later, they descend into the earth, and after remaining in the pupa state a fortnight, reappear as moths, flying all of September and October. The species ranges over the Southwest, West, and New England, and in Maine, as far north as a line drawn from Grand lake to Moosehead. Besides external enemies, it has seven internal parasites. The best way to kill out the worm is to burn meadows and grass lands, where the insect breeds, in the dead of the year.

Grain Aphis.

We now come to an insect whose transformations and habits are entirely different from those of the moth with its distinct larval and pupal stages; and eating nothing after the caterpillar is full fed. But instead, we have, hatched in the spring from eggs laid in the previous autumn, a plant louse of nearly the same form as in maturity; which by successive casting of its skin becomes a wingless female. No true larva and pupa state has been observed, though the insect may possibly undergo these changes in the egg.

We will suppose a number of eggs to hatch out their wingless females; with an occasional winged individual there are as yet no males in existence, and yet these virgin aphides or plant lice every few days produce hundreds of young, olive; each of which in turn come to maturity and produce their young alive. Hence, by the end of summer we have millions of lice over-running our wheat fields, the very youngest as well as the oldest as if for their lives sucking in the sap from the ear of the grain. For by a marvellous adaptation to their mode of life, what in beetles are jaws for biting, are here lengthened out, and joined together to form a tube, with a sucking stomach at the base. This tube the louse forces into the root of the ear, and thus anchored by their jaws, whole groups cluster head downwards on the heads of grain, and by their numbers color a whole field. But the supply of liquid food is greater than the aphides can manage, hence two tubes open out from the hind part of the abdomen, from which exudes a sweet sticky fluid called "honey dew." Ants come to eat it as it falls on the leaves, or lap it from the honey tubes of the aphis, and as the supply lessens, they gently strike the aphis with their antennæ to make them yield more.

At the approach of cold weather, when the whole race of aphides must be cut off, the virgin females produce winged individuals of both sexes, which after pairing, die out after depositing their eggs for the spring brood. Our species may possibly be the *aphis granaria* of English authors, though a strict comparison of ours and the European species must be made before deciding whether it is an English importation.

Our species is oblong-oval shaped, narrowing toward the head, while the abdomen behind is swelled out and rather blunt at the end, with a rather long ovipositor in the female. Its color is green, covered often with a reddish brown bloom. The ends of the antennæ, the end of the shanks and thighs and the feet are black. In the young these parts are only smoky or dusky. Length of those with wings about one-tenth of an inch.

Dr. Fitch gives in the "Boston Courier," interesting observations on this aphis. Of its variation in color he says: "One of the most remarkable circumstances relating to these insects is the change in their color, which now began to take place. Whilst they were scattered about upon the leaves and stalks of the grain, they were of a bright grass-green color. Now orange yellow or deep flesh red individuals began to appear among them. This color is so wholly different from green, that these orange ones might be suspected to be a different species. But green females placed in vials were found next day to have young with them of both colors—some being green, others orange. And a few days later, other green females were found to have orange young only, no green ones being born any longer. It is probably the change in the quality of its food which causes the insect to change thus in its color, the juices which the plant elaborates for the growth of its flowers and seeds being much more highly refined, nutritious and dainty, than those which circulate in the stalks and leaves, where the insect first feeds. And it is truly curious and wonderful that this green colored insect, on coming to feed on the juices which grow the flowers, begins thereupon to give birth to young having a gray orange color similar to that of the flowers."

Dr. Fitch noticed several years ago in wheat fields, a green plant louse, though it was not common.

In East Hampden, Mass., "a plant louse of a pale brick red color was extremely numerous" in 1860; so also a "red insect" on the oats in New York was sent him. We thus know the insect we are to speak of was over-running the fields in some places, last summer.

"Early in May last, when rye and winter wheat were but a few inches out of the ground, I met with this insect more numerous than any other, in every part of every grain field in my neighborhood. Towards the close of that month, specimens having wings began to occur. By inclosing them singly in vials, I found that the winged females usually gave birth to four young lice in twenty-four hours, while those without wings produced eight within the same time."

The grain aphis became noticed the 18th July in New Jersey, then in the New England States. Probably very few farms in Maine escaped its presence. About the first of August it was noticed on a farm about thirty miles above Mattawamkeag, on the Penobscot. So on farms on the lakes that form the head waters of the Penobscot and Alleguash rivers, and on the Alleguash and St. John. I also heard of its occurrence in great numbers on the St. John, in New Brunswick. Like the army worm, while abundant on some fields, others were entirely free from its attacks.

The injury this aphis does, is to lessen the weight of the grain, which of course is a matter of great consequence. The constant draining of the sap that flows into the ear, causes it to be very light, if not withered and worthless.

Artificial means of driving off this pest have not yet been contrived. It has been suggested to kindle fires, throw on damp straw and let the wind carry the smoke over the field.

But the external enemies of this aphis are ready to help us. The lady bugs, *coccinella*, as larvæ and beetles, the golden-eyed flies, *chrysopa*, as larvæ, have been seen the past season in great numbers, in wheat fields, busily engaged in devouring the plant lice.

These minute insects have also their internal parasites, little ichneumons of the genus *Aphidius*. We have to go again to Dr. Fitch's article for information respecting their habits. " On many of the wheat heads, may at present [Aug. 6,] be noticed from one to a half dozen or more of these lice, which are very large, plump and swollen, of the color of brown paper, standing in a posture so perfectly natural, you suppose they are alive. Touch them with the point of a pin, you find they are dead. Pick off a part of their brittle skin ; you see there is inside a white maggot doubled together like a ball. Put one or two of these wheat heads in a vial, closing its mouth with a wad of cotton. In a week's time, or less, you find running lively about in the vial, some little black flies, like small ants. These you see have come out from the dead lice, through a circular opening which has been cut in their backs. Drive one or two of these flies into another vial, and introduce to them a wheat head having some fresh lice. See how the fly runs about them, examining them with its antennæ.

Having found one adapted to its wants, watch how dexterously it curves its body forward under its breast, bringing the tip before its face, as if to take accurate aim with its sting. There, the aphis gives a shrug, the fly has pricked it with its sting, an egg has been lodged under its skin, from which will grow a maggot like that first seen inside the dead swollen aphis. And thus the little fly runs busily around among the lice on the wheat heads, stinging one after another, till it exhausts its stock of eggs, a hundred probably, or more, thus ensuring the death of that number of these lice. And of its progeny, fifty it may be supposed, will be females, by which five thousand more will be destroyed. We thus see what efficient agents these parasites are in subduing the insects on which they prey. I find three different species of them now at work in our fields, destroying this grain aphis."

Now whether these insects will appear in such numbers in coming years, or again be rarely seen; and what are the causes of their great increase, we cannot tell. The army worm seems to be only an occasional visitor, and may not occur abundantly for several years. The aphis may be very troublesome for some years to come, and then gradually take its place among those insects which do each year considerable damage to grain. How to account for the sudden and marked increase of these or any other insects, once in five, twenty or fifty years, we do not know. Favorable or unfavorable seasons, the scarcity or abundance of parasites, and other physical influences that cause species to be rare or common in different seasons, do not satisfactorily to us, account for the fearful increase of the army worm and grain aphis in the summer of 1861.

GENERAL REPORT

UPON THE

GEOLOGY OF MAINE.

BY C. H. HITCHCOCK.

Inasmuch as this report is to be circulated chiefly among those who have never found time to devote much attention to scientific study, it has been thought by some that the elements of geology should constitute its chief portion. But little need be written preliminary to the account of our explorations the past season, because a general knowledge of geology is already possessed by intelligent men; and especially because four reports upon the Geology of Maine, made twenty years ago by Dr. C. T. Jackson, have already been distributed throughout the State. We will notice therefore only such fundamental features of the science as have an intimate connection with the details of the report.

Stratified and Unstratified Rocks.

Geologists consider it settled that the earth was formerly a mass of molten matter similar to lava, assuming its present shape of a flattened sphere while its materials were thus plastic. As the medium in which the earth revolves is intensely cold, (at least 75 degrees below zero,) the tendency of the heated mass must have been constantly to throw off heat, and this at length to form a crust upon the surface of the spheroid. As soon as the crust became sufficiently thick for water to accumulate upon it, the process of denudation commenced, wearing away the higher parts of the envelop and depositing the detritus in the lower portions of the surface, or the valleys. At present the radiation of heat from the interior melted mass cannot be great, as the crust must be more than a hundred miles thick.

The original mass of the earth and all igneous rocks are said to be *unstratified*, because they are not arranged in layers. On the other hand the rocks which have been formed by the deposition of the worn fragments of the original surface are said to be *stratified*, because they are arranged in layers, like a pile of boards. They have all been formed under water; either fresh water or marine. Many of the layers or *strata* are subdivided into very thin plates like the leaves of a book, which are called *laminæ*. Slaty rocks are often traversed by divisional planes resembling laminæ, called *cleavage planes*, because the slates naturally cleave in the direction of these planes. Frequently the cleavage planes coincide with the laminæ. Another class of divisional planes called *joints* cross the strata in different directions and divide them into rhomboidal masses, parallelograms and cubes. The unstratified rocks are traversed by joints. Cleavage planes and joints are called *superinduced* structures because they have been developed by chemical forces since the original production of the rock.

Clay, sand, gravel and calcareous deposits, (such as are produced from mineral springs,) are the original forms of most of the stratified rocks. By various agencies these materials become consolidated into slates, sandstones, conglomerates and limestones; so that the newer rocks are generally more friable and less compact than the older rocks. The slates, sandstones, etc., which have been formed under similar circumstances during one geological period, and contain relics of the animals and plants living during that period, are called a *formation*.

The strata composing the different formations were originally horizontal. Now an examination of the strata along a given line, or a *geological section*, shows that the stratified rocks are tilted up at various angles, and that some layers have been forced up so as to stand upon their edges. Some great force in nature seems to have been at work gradually for ages, pushing the strata into great curves, of which the strata we examine in a section are parts. Hence it is easy to see how one is enabled to examine the oldest stratified rocks and all that have been formed since the earliest period. One formation has been elevated so that the character of its layers can be ascertained at the surface, and the formations which have been deposited since lie upon the older formation without concealing it entirely from view. Had there been no disturbances of the earth's crust, and had the formations encircled the earth one over another, like the concentric coats of an onion, it would have been impossible to examine the oldest formation without excavating a passage through all the layers above it. Occasionally one formation has been elevated or tilted up before the formation immediately succeeding has been deposited. In such case the strata beneath are said to *underlie unconformably* the strata above with a less inclination.

Fossiliferous and Unfossiliferous Rocks.

An easy and natural division of the stratified rocks is into those which contain evidences of organic life and those without fossils—or the fossiliferous and unfossiliferous or Azoic rocks. A *fossil* may be defined as any relic or trace of an animal or plant buried naturally in the earth. In general, the unfossiliferous rocks are the oldest, of immense thickness, but not so thick as the ten or twelve miles of fossiliferous rocks overlying them.

Paleontology is the science of fossils or organic remains. From the study of fossils the following general statements have been deduced.

1. The whole number of species of animals and plants found fossil and described amounts to at least 35,000, of which 2,750 are plants.

2. Each formation is characterized by its peculiar group of fossils not found in any other, so that a paleontologist on seeing a specimen can usually tell from what part of the series it came.

3. The fossil species in Maine and the northern parts of the continent correspond more nearly to animals now living in the tropics, than to those now living in the colder climates. Hence the climate of even the Arctic zone must once have been tropical.

4. There have been at least six entirely different races of animals and plants upon the globe; and some authors estimate as many as twenty-seven life periods. Each economy of life seems to have entirely disappeared before the appearance of the succeeding race, and each successive group must have been introduced, as was the first one, by the action of an intelligent creator.

5. There are no animals now existing at all similar to many of the strange forms peopling the Preadamic world.

6. The successive groups of animals and plants are each more perfect than the one preceding: and the last group, or those now living, embraces the highest types of the animal and vegetable kingdoms.

Classification of Rocks.

The fossiliferous rocks may be divided into three great systems, according to the times when the successive economies flourished:

1. The *Paleozoic* system of life, or the *ancient*—the oldest—types of being: 2. The *Mesozoic* system of life, or the types that flourished during the *middle* periods of organic life: and 3. The *Cainozoic* system of life, or the *recent* types of life. These are only general divisions. The subdivision of strata has now been carried to great nicety.

A formation in America is identified with the corresponding strata in Europe by means of the organic remains *characteristic* of that group. Previously the European strata had been examined, and had received a local name, giving it a definite place upon the series. For example, one of the lowest formations of the Paleozoic system was first explored in Wales. Hence it was called *Silurian*, (from an ancient name of the country.) Now when strata of the same age are found in America they are termed Silurian, *i. e.* strata of the same age with those in Siluria. The term Silurian is yet a general one. It has been subdivided into thirteen parts in England, and into sixteen in North America, each being named from the town or region where it is best developed.

The unfossiliferous stratified rocks, as well as the unstratified, are at present classified according to their lithological structure.

We present here a tabular view of all the stratified and unstratified rocks, arranging the former in the order of their age, mentioning the most recent first.

A.—STRATIFIED OR AQUEOUS ROCKS.

I.—FOSSILIFEROUS.

1. *Cainozoic.*

1. Alluvium, including Drift.
2. Tertiary.

2. *Mesozoic.*

1. Cretaceous, with Green Sand.
2. Oolite or Jurassic, with Wealden and Lias.
3. Triassic, or New Red Sandstone.

3. *Paleozoic.*

1. Permian.
2. Carboniferous.
3. Devonian, or Old Red Sandstone.
4. Upper Silurian.
5. Lower Silurian.
6. Cambrian, (or Huronian.)

II.—UNFOSSILIFEROUS OR AZOIC.

Laurentian.

B.—UNSTRATIFIED OR IGNEOUS ROCKS.

I.—GRANITIC GROUP.

1. Granite. 2. Syenite. 3. Protogine.

II.—TRAPPEAN GROUP.

1. Porphyry. 2. Greenstone. 3. Amygdaloid, etc.

III.—VOLCANIC ROCKS.

1. Bassalt. 2. Trachyte. 3. Pumice. 4. Tufa. 5. Peperino. 6. Volcanic Ashes. 7. Vesicular lava, etc.

The fossiliferous rocks of Maine are mostly Paleozoic, and probably below the Carboniferous series. The rest belong to the Alluvium. Probably the subdivisions of the Paleozoic rocks in Maine will correspond neither with the subdivisions of these rocks in England nor with those west of the Green Mountain range. As there will be constant references to these subdivisions elsewhere, both in this report, and in the future progress of the examination of the rocks of Maine, we will give in a table their names as used in England and North America. Much labor must be spent in ascertaining how near the subdivisions of the Paleozoic rocks of Maine correspond with the others. At present it is impossible to compare them because the thickness and extent of these rocks in Maine are not known.

	England.	*New York, etc.*	*British Provinces.*
Carboniferous.	Coal Measures. Millstone Grit. Mountain limestone.	Coal Measures. Conglomerate. Carboniferous limestone. Conglomerate.	Carboniferous of New Brunswick and Nova Scotia.
Devonian.	Dartmouth slate group. Plymouth group. Liskeard or Ashburton group.	Catskill red sandstone. Chemung group. Portage group. Genessee slate. Hamilton group. Marcellus shales. Upper Helderberg limestone. Schoharie grit. Cauda-galli grit. Oriskany sandstone.	Gaspe sandstones of Canada.
Upper Silurian.	Tilestone. Upper Ludlow rock. Aymestry limestone. Lower Ludlow rock. Wenlock limestone. Wenlock shale. Woolhope limestone. Denbigshire sandstone. Tarannon shales. May Hill sandstone.	Lower Helderberg limestone. Waterlime group. Onondaga salt group. Niagara group. Clinton group. Medina sandstone. Oneida conglomerate.	Gaspo limestones of Canada. Arisaig series of Nova Scotia.
Lower Silurian.	Lower Llandevery beds. Caradoc sandstone and Bela beds. Llandeilo flags. Lingula flags.	Hudson River group. Utica slate. Trenton limestone. Bird's eye limestone. Black River limestone. Chazy limestone. Calciferous sandrock. Potsdam sandstone.	Qubec group of Canada. Paradoxides beds of Nova Scotia.
Cambrian.	Longmyn rocks.	Huronian (at Lake Huron.)	

The Carboniferous system of this country is from 6,500 to 14,500 feet thick. The Devonian rocks are 11,950 feet thick. The Upper Silurian rocks are about 4,800 feet thick. The Lower Silurian rocks are estimated from 1,800 to 8,500 feet in thickness. The Huronian rocks are 12,000 feet in thickness.

Metamorphism.

The rocks originally deposited were mostly sandstones, shales, conglomerates and limestones. But many of them have undergone great alteration in their physical characters since their production. Heat, water and chemical forces with various degrees of intensity have been converting many sedimentary rocks into crystalline masses, so that often the original features of the formation are entirely obliterated. The pebbles may disappear or be so distorted as not to be recognizable; shales become slates; fossils are obscured; and often a superinduced structure becomes far more prominent than the original planes of stratification. This transformation of rocks from one kind to another is called *metamorphism.*

Denudation and deposition accumulate together a mass of heterogeneous materials, mixed together without reference to a chemical arrangement of the particles. The process of metamorphism consists analytically of two parts: first, the production of the conditions in which chemical forces can act, and secondly, the action of these chemical forces. The conditions favorable to the development of the forces are plasticity of the materials in connection with the presence of warm water or steam. Under these circumstances the laws of chemical affinity cause the different elements to form such new combinations as the conditions require. Sometimes a portion of the ingredients of the sedimentary rock are removed in this change, leaving the other ingredients only to form the altered rock. The results become somewhat complicated when new ingredients are introduced into the sedimentary rocks, held in solution by the water diffused through the plastic materials. We suppose that the greater amount of metamorphism is produced by the latter method.

Many metamorphic rocks are foliated. *Foliation* is a change in metamorphic rocks analagous to cleavage. It is a *crystalline lamination,* or a separation of the different mineralogical compounds into distinct layers much resembling strata. Generally the foliated planes correspond with the planes of stratification, otherwise they cross the strata like cleavage planes. The rocks in which foliation exists are called *schists*. The term *slate* ought to be limited to those fissile rocks that are homogeneous, and schist to those where the materials are heterogeneous, and are arranged in alternate layers.

The following are those rocks which have been metamorphosed from sedimentary strata: Quartz Rock, Clay Slate, Mica Schist, Talcose Schist, Steatite, Serpentine, Hornblende, Gneiss and Saccharoid Azoic Limestone. Probably most of the Granitic group of unstratified rocks have been altered from Gneiss, Hornblende Schist and Talcose Schist.

Whenever therefore the geologist finds an Azoic rock the question immediately arises, What is the age of this rock? Is it Laurentian, Devonian or Carboniferous? There is comparatively little difficulty in determining the age of fossiliferous rocks on account of the fossils; but as fossils are wanting in the Azoic rocks some other course must be adopted. There are two ways of ascertaining the age of Azoic rocks. By one method the identity of an azoic with a fossiliferous rock may be determined by following one of them along the line of its strike until it passes into the other. By the other method we may determine the age of the azoic rock proximatively, by noting what formation lies beneath it and what formation lies above it. Azoic rocks have been found even in the Tertiary group.*

A large part of the rocks of Maine are metamorphic. They are doubtless all below the Coal Measures, but whether they are Devonian, Silurian, Cambrian or Laurentian, or all of them, is at present unknown. It will be a part of the work of the Scientific Survey to answer this question. Though the question appears purely a matter of curiosity, yet practical issues are dependent upon its decision. This leads us to speak of the

Utility of a Geological Survey.

In the first place, the geological survey of a State develops its mineral wealth. Valuable mines of metals and quarries of useful and ornamental building stones are locked up in the solid rocks, which will remain in obscurity until developed by accident or systematic exploration. Modern science has found uses for many substances previously considered worthless. There are often connections between widely separated deposits of the same substance, which only an acquaintance with the earth's crust will discover. A strict examination of a State ought to develop its most important subterranean resources.

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* Those who wish to learn more of the elements of geology than can be derived from this report are referred to our text-book on this subject—*Elementary Geology, by Edward Hitchcock and Charles H. Hitchcock, for use in schools, families, and by individuals; Thirty-first Edition;* published by Ivison, Phinney & Company of New York.

Facts show of how great advantage geological surveys have been. The help afforded to quarrymen and miners by the geological examination of such States as Vermont and Canada has more than repaid all the expenses of exploration. In a new country where settlements have never been made, the opportunity for developing new mineral resources is greater than in thickly populated districts.

In the second place, the geological survey of a State points out clearly those districts where no valuable mines or quarries can be worked. In our view this is the most important result of a scientific survey. There are very few towns in New England where some of the inhabitants do not believe that they live adjacent to rich subterranean treasures. An Indian has chopped off a piece of lead from a ledge and run it into bullets, or some one has been secretly treasuring up a few worthless minerals closely resembling the precious metals. Very often the reputed original discoverer has refused to disclose the locality of the valuable substance, yet its existence in large quantities is steadfastly believed. A systematic exploration can very easily eliminate the worthless from the valuable in all these and scores of similar cases, and forestall useless expenditure. It would surprise one not familiar with the subject to learn how numerous have been the outlays of capital in the vain search for valuable ores. Doubtless a volume could be filled with brief accounts of the losses sustained by the citizens of Maine alone in these unfortunate efforts. Probably a scientific exploration at the outset would have developed the true character of the localities, and saved many thousands of dollars, besides an immense amount of mortification and disgrace.

In the third place, the geological survey of a State furnishes a basis for intelligent agricultural operations. It furnishes data from which to judge of the character of the soil. By its aid the different soils of a State may be classified according to their relative values, and their respective areas be represented by colors upon a map. Such a map might lead farmers to select the best sites for their labors, particularly in moving into a new country. A thorough examination of the different soils may point out what materials ought to be added to make them more productive.

A geological survey aids the agricultural interest also by pointing out deposits of natural manures. Opportunities of this sort are generally quite abundant.

In the fourth place, the geological survey of a State diffuses much scientific information in that State, and encourages the study of the works of nature. The benefits resulting from the acquisition of theoretical knowledge are not generally reckoned in dollars and cents; still they have a pecuniary value. The liberalizing bias given to a young man by scientific knowledge may be a source of pleasure to him in later years, as well as prevent him from dissipation. The possession of this tendency is worth thousands of dollars to him. Would it not be financially desirable even to educate the scholars of the common schools in the general principles of the natural sciences? It can be established by statistics that wealth is the most abundant where there is the greatest amount of general information.

Rock formations in Maine.

The formations in Maine are both metamorphic and fossiliferous, the former predominating. The following metamorphic stratified rocks occur in Maine:

Gneiss,
Mica schist,
Talcose schist,
Steatite and Serpentine,
Saccharoid Azoic Limestone,
Clay slate,
Quartz rock and conglomerates,
Jasper,
Siliceous slate,
Hornstone.

It is difficult as yet to say whether any of these Azoic rocks belong to the Laurentian series or the Paleozoic system. Scientific men are now discussing this very question in connection with some side issues, not confining their discussions by any means to Maine.

The following unstratified rocks are found in Maine. As to their ages the same may be said in general as was said respecting the age of the Azoic stratified rocks. There are a few exceptions, which will be specified in the body of the report:

GRANITE,
SYENITE,
PROTOGINE,
PORPHYRY,
TRAP OR GREENSTONE,
EURITE.

The fossiliferous rocks of Maine are all Paleozoic, except certain marine Alluvial deposits. They probably belong to the following groups:

LOWER SILURIAN,
UPPER SILURIAN,
DEVONIAN,
DRIFT AND ALLUVIUM.

Geological Map.

From the observations we have made during the summer, and from Dr. Jackson's printed reports, we are enabled to construct a geological map of the whole State, representing upon it the different rocks by different colors. As this map is imperfect, it is deemed advisable to suspend its publication for the present; but a manuscript copy of it is presented with this report, so that in case the work of exploration should cease, the total results of all previous explorations will not be lost. Every year's work will make this representation more perfect. We proceed now to describe the character and distribution of the Azoic stratified rocks of the State.

GNEISS.

This rock is composed of successive folia of quartz, mica and feldspar. The constituents are the same as those of granite. As in granite the mica and the feldspar are generally the potash mica and the potash feldspar; especially in Maine. When gneiss contains crystals of feldspar which give it a spotted appearance, it is said to be *porphyritic*. It is *granitic* when it is difficult to distinguish it from granite. Hornblende and epidote are sometimes so abundant in gneiss as to give it a distinctive character, when it is called *hornblendic* and *epidotic*. Gneiss is often distinguished for the regularity and evenness of the stratification, by which it is rendered an excellent building stone.

The principal deposit of gneiss in Maine is near the coast, extending from Westbrook eastwardly across Penobscot bay. The deposit second in size is in the north part of Oxford county. The other deposits are in small patches, mostly in the south-western part of the State.

In Westbrook, rather more than a mile west from Portland is a remarkable hill of gneiss which might easily be mistaken for granite. This is near the south-west end of the deposit. Much of the gneiss in Westbrook is deficient in feldspar, and might almost be called mica schist. Proceeding north-westerly in Falmouth and Cumberland its true character appears more distinctly. It is very easy to mistake much of this gneiss for granite. Gneiss is the rock certainly of the following localities in Cumberland and Sagadahock counties, and may embrace more; the south-east parts of Falmouth and Cumberland, and the whole of Yarmouth, Freeport, Brunswick, Topsham, Bowdoinham, Richmond, Woolwich, West Bath, Bath, Phipsburg, Arowsic, Georgetown, Westport, and the south part of Gardiner. The greater part of Lincoln county is underlaid by gneiss. In Knox county, Friendship, Cushing, Warren and Hope, are the towns occupied by gneiss. Lincolnville and Northport are largely occupied by the same rock. It has been traced over to Bluehill across Penobscot bay.

The details of the character and position of the rocks in the different parts of this deposit are not interesting. There is great uniformity in them. The prevailing character of the rocks in the western part of this area is an interstratification of the granitic variety with rather an obscure gneiss. Occasionally the occurrence of beautiful minerals affords a pleasing variety to the eye, as the large crystals of tourmaline in Falmouth, the beryls in Bowdoinham, the garnets and black tourmaline of Brunswick, and the yellow garnets, idocrase and laumonite of Phipsburg. The gneiss in Brunswick is traversed by enormous veins of granite containing large crystals of feldspar which is suitable for the manufacture of porcelain wares. The foliated character of the granitic gneiss may be seen distinctly in West Bath where there are immense beds of this variety. The surface in Bath and adjacent towns along the coast is undulating, but the ridges have a uniform northerly and southerly direction, corresponding in Bath to the course of the strata. The whole of Phipsburg is underlaid by gneiss which is numerously intersected by granitic veins. The gneiss of Lincoln county is not especially interesting. Along the coast the following points and islands are composed of gneiss: Franklin Island, Pemaquid Point, Boothbay, Cape Newagen, Squam Island.

Rockland and Thomaston are underlaid by a peculiar mica schist, quartz rock and limestone, more recent than the gneiss, and overlying it. North of Rockport a short distance, the same gneiss appears, though in an obscure form, and it continues through Lincolnville into Northport along the shore of Penobscot bay. A part of Megunticook mountain in Camden is composed of gneiss. The prevailing dip of all the gneiss thus far described is to the south-east. A north-westerly dip is occasionally seen near the coast east of Bath.

Other localities of gneiss. Quite a number of limited patches of gneiss different from the great deposit just described, are reported from different sources. The following are in the vicinity of the great deposit. In Hallowell there is granitic gneiss, which is extensively quarried. In Frankfort there is the common gneiss and granitic gneiss, the latter resting upon granite, and both dipping north-west. The gneiss at Bluehill is probably not connected with that in Knox county, unless it be beneath the intervening schists. Bluehill mountain is composed of exceedingly distorted layers of gneiss. The same rock is found at Bluehill Neck and on the north part of Long Island in Bluehill bay, in both places dipping beneath granite. There is a small patch of gneiss in the south part of Orrington.

There appears to be gneiss along the track of the railroad between Danville Junction and Greene, and perhaps this belt of rock may be connected with the gneiss in the west part of Winthrop. A part of Davis' mountain in Newfield is composed of gneiss. In the east part of Oxford county there appears to be a considerable gneiss in the towns of Paris, Norway, Greenwood and Woodstock. That in Paris is upon the opposite sides of Streaked mountain. Farther north gneiss is also found in Dixfield, Umbagog, Mount Blue in Avon, and at a high ledge near the south end of Moosehead Lake, upon the eastern shore, called Burnt Jacket. The latter is a high rocky point a hundred feet high, composed of gneiss traversed by numerous veins of quartz, and containing crystals of black tourmaline and andalusite. Most of the southern and eastern parts of Somerset county are underlaid by gneiss.

MICA SCHIST.

Mica schist consists of alternate layers of mica and quartz, but passing insensibly into other schists, the talcose and hornblende.

When the quartz is deficient it verges towards clay slate; and when the mica is deficient it passes into quartz rock. The most important variety in Maine is the calciferous; not that it is the most abundant, but the most interesting and valuable. It is both true mica schist interstratified with impure limestones, and real mica schist that is largely composed of calcareous matters. Other varieties found in abundance in Maine are the plumbaginous and pyritiferous schists—the one containing black lead, and the other pyrites.

There are several ranges of mica schist in Maine. A pyritiferous variety is found upon Jewell's Island near Portland, which belongs to a range east of all others. Another narrow range which is plumbaginous, begins at Prout's Neck in Scarborough, extends to near Fort Preble in Cape Elizabeth, and shows itself again on Hog Island in Casco bay. This is a rock which has always excited attention because of its resemblance to anthracite coal. The strata of both these ranges stand upon their edges, and their course is north-east and south-west, like that of all the formations in western Maine. Some of the rocks on Orr's Island are micaceous schists. All these micaceous rocks about Portland are exceedingly obscure in their mineralogical character.

Not so, however, is the next range west, which is probably of great extent. We have examined it in Windham, Gorham and Standish, and find it well characterized, containing in abundance garnets, staurotide and kyanite. The calciferous variety occurs at J. F. Anderson's in Windham, and on the Charles Haughton place in Gorham, where an attempt has been made to manufacture quicklime from it. This belt is cut off by granite near Sebago pond, and is seven miles wide. It has been traced into Buxton where it narrows to a point in granite. Its extent to the north-east is unknown to us; but we suppose the portion just described to be the south-western terminus of an immense deposit of mica schist in Androscoggin, Kennebec and Waldo counties, extending nearly to Penobscot river, where it is succeeded by clay slate. Large patches of granite are frequently found in it, which were protruded subsequently to the deposition of the schist. From Danville to Belgrade the mica schist has been seen to occur, and this line is probably near the western limits of the basin. In Winthrop the mica schist is more distinctly crystalline even than in Windham. From South Gardiner to North Vassalborough is another section crossing the range which we have traversed. The dark-colored rocks of Augusta are mostly mica schist. East of the Kennebec river the mica schist is found in Whitefield, Troy, China, Palermo, Montville, Liberty, Jackson and Searsmont, and we presume in all the intervening territory. A section from the west part of Bangor to Etna discloses the presence of an argillo-mica schist over the whole distance. The dip of the strata in the east part of Carmel is to the north-west, in Carmel it is to the south-east, and beyond Carmel it dips to the north-west again. This range will be noticed again.

In the north-west part of the State there is much mica schist, which may possibly be connected with the last deposit. It appears in the towns of Poland, Turner, Buckfield, Livermore, Farmington, Vienna, Mount Vernon, on Bear Mountain in Hartford, Woodstock, Andover Surplus, Rumford, Mount Blue in Phillips, and Mount Abraham, in the north part of Franklin county.

Mr. George L. Goodale has made a geological map of part of Oxford and the whole of York county, upon which are colored the following ranges. A short one in Upton. One from New Hampshire extending into Gilead, Newry and Rumford. A wide range in Albany, Stoneham, Mason and Lowell. One in Brownfield. One in Denmark and Bridgton. One in Hiram, Porter and Ossipee, N. H. One in Acton and Middleton, N. H. One in North Berwick. A wide one from Berwick to Kittery Point. It is remarkable that the strata run across this range at right angles to its course. It would appear hence that the granite of southern York county is metamorphosed mica schist. Another range from Kittery Point to Kennebunkport or perhaps to Fletcher's Neck in Biddeford. A small patch in the north part of York. Another in the west corner of Biddeford. And finally a large but interrupted range in Saco and Buxton. The course of the strata in all these ranges is invariably north-easterly.

In the eastern part of the State we find other deposits of mica schist, less metamorphic. The best characterized one is on the eastern shore of Knox county, associated with the Rockland and Camden limestones. This deposit is referred to the Taconic system by Professor Emmons. Its distribution is too irregular to be described without a colored map. It appears to be more or less interstratified with limestone and quartz rock. Islesborough, Deer Island and the Fox Islands appear to be composed of mica schist, traversed by numerous dykes. These strata are highly plumbaginous and pyritiferous. At Webster Head in Vinalhaven, there are said to be two beds of anthracite coal, each an inch wide. This cannot be in the true coal formation. Beds of coal are found in almost all the formations, but are seldom of value except in the true coal formation about midway in the geological series.

Farther up Penobscot river on both banks are strata apparently belonging to the same group. At Brooksville, on the east side, they are pyritiferous. At Camden, there is the greatest variety in the rocks. The features of the country are very much like those of western Massachusetts and Vermont, where the so-called Taconic rocks are developed in the greatest perfection of any locality in the country. Megunticook mountain in Camden, resembles some parts of the Taconic range. It rises very abruptly from an uneven country and its commanding presence inspires the beholder with an almost irresistible desire to ascend it. Near its steep sides there is a mica schist, the same that occurs at the village of Camden. The rock of the mountain seems to be a brecciated or conglomerated mass of pebbles, cemented by a fine siliceous paste, crossed by joints, one set running north 75 degrees west, and the other north 10 degrees east. The pebbles seem to have been derived from a quartz rock, probably from the quartz of mica schist and granite; though possibly from the quartz rock to the south of the mountain. The thickness of the strata composing the mountain must be about five hundred feet, as they dip south-east about twenty degrees; while the height of the mountain is 1,457 feet above the ocean.

A belt of rocks of indistinct talcose or micaceous character is found at Belfast, on the north side of the gneiss of Lincolnville and Northport. Andalusite is common in them. Another micaceous belt of rocks appears at Bucksport and vicinity. Across the river at Bucksport, the rock appears in regular sheets well adapted for paving stones, etc., dipping 75 degrees east. Fort Knox, in Frankfort, is situated upon mica schist dipping 30 degrees northerly. Mica schist and hornblende schist occur in Bucksport village. In the north-west part of Orland, near a church, the mica schist appears, dipping 55 degrees south-easterly. It passes into jasper on Long pond brook, in the east part of Bucksport.

Another large basin of mica schist is in the south part of Hancock county, resting mostly upon granite, certainly upon three sides. This granite seems to be shaped like a great horse shoe—one end being Mount Desert Island, running through Sullivan, Franklin, Number eight, north part of Ellsworth, Orland, Surry, Bluehill and Sedgwick, to its other end on Deer Isle; and the mica schist is situated within this curve. The character of the rock is gneissoid and sometimes talcose, and again like siliceous slate. The country within this area is low and rolling; while the great granite curve is composed of high mountains. It is a fine place when one is standing upon the granite highlands, (e. g. upon the lofty mountains in Mount Desert,) to learn what the geologist means when he speaks of a basin. The grand foundation beneath all the low land to the north-west is granite, and after this large depression (basin-shaped) had been formed by the upheaval of the granitic ranges around the lowland, the schists were deposited in it. But in this case the deposits failed to reach any where near to the top of the edge of the basin. Nor do the strata seem to have been disturbed very greatly. We consider the rocks in this great valley as belonging to one formation and as formed during the same geological period. It is possible that this basin connects with the Rockland schists just described through the open portion of the curve near Deer Isle. Our observations were not sufficiently extended in that direction to settle this question.

In passing from Calais northerly to Aroostook county, we travel over two more belts of mica schist, which probably are the same layers of rock repeated by a synclinal fold. Leaving the granite range in the east part of Baring, mica schist, often calciferous, appears with a north-westerly dip as far as Princeton, where it is succeded by clay slate. At Dudley's hotel in Waite, the calciferous mica schist appears again and extends to the granite range in Topsfield, but with a south-westerly dip. Thus the clay slate appears to lie in a trough of the calciferous mica schist. The extent of the two bands of schist to the south-west leads to an unexplored portion of the wild lands, so that the lateral dimensions of this formation cannot be given. Mica schist occurs in limited amount in the north part of Topsfield, and the north part of Weston, in Aroostook county. The character of the micaceous rocks in Aroostook county will be given in full in the second part of this report, where may be seen also a section of the rocks between Charlotte and Presque Isle.

TALCOSE SCHIST.

This rock consists normally of successive layers of talc and quartz. Often the talc is replaced by talcite or some mineral resembling talc. Talc is a hydrous silicate of magnesia, but the substituted minerals are silicates of alumina. Hence what is often called talcose schist is only an altered variety of clay slate. From some analyses of these schists in Vermont, performed under our direction, we have reason to believe that the true talcose schist is a rare variety among the so called talcose schists, in all parts of the world. We have found specimens among the talcose schists of Maine which go to confirm this opinion. Much investigation is yet needed upon this subject, and it is to be hoped that the Maine Survey will be permitted to clear up many of its obscurities.

Talcose schist is less abundant in Maine than the two rocks just described. There are five or six different deposits of it. One of them is in Cumberland county, near Portland. It appears to extend laterally from Saco to Orr's Island. We have observed it in two places in the east and south-east parts of Saco. Cape Elizabeth is largely composed of talcose schist. Near the light houses on Cape Elizabeth, this rock exhibits a remarkable tendency to split in the direction of the layers, like wood. And where it is laid up to form fences, the resemblance of the fibrous masses to wooden rails and planks is very striking. The city of Portland is underlaid by it also, interstratified with some mica schists. North-east of Portland this rock appears upon most of the Islands in Casco bay; also in Harpswell. In a sketch of the Geology of Portland and vicinity, written by my father in 1836, the rocks of this basin are represented to be interstratified beds of talcose schist, mica schist and quartz rock, the former decidedly predominating. It is unusual to find a single metamorphic rock in one basin; more often several different kinds are interstratified with one another, though one variety may so predominate over the others as to give a name to the group taken collectively. My father has suggested the similarity of these rocks about Portland to those elsewhere in the United States that contain gold. As gold is now found in so many localities where its existence was not formerly suspected, it may be well to examine the foundations of Portland for it.

In connection with the mica schist of Rockland, Thomaston, Camden, etc., more or less of talcose schist is associated. Whether it can be separated stratigraphically from the mica schists already described from these localities remains to be seen. At Goose river, in Camden, this rock has been described as the "magnesian slate" of the Taconic system. The rocks at Belfast are largely composed of talcose schist. They form a belt several miles in width, and of unknown extent north-easterly and south-westerly. They seem to be of different age from the Thomaston group; perhaps synchronous with the Portland schists.

We have discovered two or three new deposits of talcose schist in the wild lands. One is on the waters of the St. John river above the mouth of Little Black river; and the other we crossed on the Aroostook road between Patten and the north part of No. 6, R. 5. A narrow belt of this rock we crossed also in the north part of Hodgdon, near the New Brunswick line.

There is doubtless a large amount of talcose schist in the immense clay slate formation in the central part of the State. Over much of this area the two rocks are interstratified, the latter predominating. We hope in future to be able to distinguish large areas wholly occupied by the schist in the slate regions. The rock between Mattawamkeag point and Lincoln, on the Penobscot river, is really more like the schist than the slate. There is talcose schist also in Charleston and Dixmont.

Serpentine and steatite or soapstone are generally reckoned as rocks allied to talcose schist. These are not abundant in Maine. The former occurs at Deer Isle, and the latter in Harpswell, Orr's Island, Jaquish, and probably in North Sidney and North Vassalborough.

SACCHAROID AZOIC LIMESTONE.

The limestones connected with azoic rocks are generally white and highly crystalline, resembling loaf sugar so much as to be called *saccharoid*. In some situations it is dark colored, or it may receive bright colors from minerals disseminated through it. It is often highly magnesian, when it is called *dolomite*. These limestones generally occur as beds in schists. This is true of all the azoic limestones in Maine, except perhaps the large deposits of this description in the vicinity of Rockland and Thomaston. The details of the beds of limestone in Maine are numerous, but we will describe them as briefly as possible.

In York county limestone is found in the south-west part of

Newfield, in gneiss rock; also at Fogg's mills in Limerick. In Cumberland county it is found at Cape Elizabeth, Gorham and Brunswick. That at Cape Elizabeth is not pure, being mixed with slaty matter. It is blue, traversed by white veins of calcite, and occasionally of quartz. It would make a handsome variegated marble. In appearance it is like some of the Thomaston limestones. This bed is probably several miles in length, but its absolute extent can be ascertained only by excavation. In the south-eastern part of Brunswick there are three or four beds of white limestone, from nine to twenty-two feet in thickness, and of unknown length. The largest is near the house of Mr. Jordan. The limestone at Gorham is of inferior quality, and is in the mica schist formation. A limestone like that at Gorham is found near Mr. Moulton's upon the shore of Sebago Lake in Standish.

In Oxford county the azoic limestone appears in Norway, Dixfield, Paris, Buckfield and Rumford. In Norway and Paris the localities are represented to be very numerous, so much so that it "would be tedious to enumerate" all of them. One of them in Norway is of a greenish gray color, and contains 51.4 per cent. of carbonate of lime. It occurs in abundance in Buckfield, in two different parts of the town. The Dixfield limestone is a dark bluish gray micaceous limestone containing 79.6 per cent. of carbonate of lime.

Just below the Great Falls at Rumford, there is a bed of a coarse grained limestone, containing scattered green crystals of actynolite and pargasite in small grains and fibres; also in connection with them other minerals, as yellow garnet—crystalized and massive—sahlite, augite and asparagus stone (phosphate of lime.) The limestone contains 78 per cent. of carbonate of lime.

In Androscoggin county the limestone appears in Turner, Poland, Livermore, Lewiston. In Turner it is found in different parts of the town. That in Poland is upon N. Bray's land, and is of a greenish white color, granular, containing 43.6 per cent. of carbonate of lime.

In Turner there are two beds of limestone. One upon S. Davy's land is grayish white, granular, contains crystals of actynolite and 74.6 per cent. of carbonate of lime. The other is upon Oak Hill. It is greenish gray, granular, and contains 40 per cent. of carbonate of lime.

In Franklin county the beds of azoic limestone are more numerous and valuable. They are found in Jay, Wilton, New Sharon, Carthage, Temple, Farmington, Industry, Strong, Phillips, Kingfield and on Mount Abraham. There are several of these beds in Phillips. One of them is a mile northerly of the village on Mr. Joel Whitney's estate. The rock is grayish white and bluish white, occurring in mica schist, with a northerly inclination of 60 degrees. There are two beds here side by side, one ten and the other thirty feet wide, and they have been traced at least twelve hundred feet laterally. It contains 65 per cent. of carbonate of lime. There are two large beds of limestone upon the west side of Sandy river in Phillips; also several more upon the east side of Sandy river on the road to Freeman. A specimen from one of the latter localities contains 67 per cent. of carbonate of lime. In Wilton there is a bed of limestone in mica schist one mile from Holman's hill. Transparent crystals of calcite or pure carbonate of lime occur in it. The limestone is of good quality. In Carthage there are several valuable beds of limestone. The most important occur in the south part of the town near the Dixfield line, on Mr. Isaac Reed's land. They are on the side of a precipitous hill; two in number, inclosed in mica schist, and dipping 40 degrees north-westerly. The hill is eighty or ninety feet high, and the cliff of limestone is sixty-six feet high. The width of the southern bed is sixty-seven feet—of the northern bed twenty feet. Its length could not be measured because it is covered with earth. North-west of this locality there are several other beds—one of them being superficially eighty feet wide. Still another one in the same vicinity is sixty feet wide. The limestone on Reed's land contains 76.2 per cent. of carbonate of lime; one of the others contains 89.8 per cent. the latter being much the purest.

In Temple, upon the estate of Joel Varner, there are several beds of blue granular limestone from ten to thirty-five feet wide, and traceable laterally a great distance. These beds are enclosed in talcose schist of such a degree of softness that it can be easily cut and made useful like steatite. These beds dip to the north-west. There are several beds of limestone in Farmington. One a little east of the village in Stoyell's pasture exhibits strata dipping 78 degrees north-west. Another near by on J. Coney's land, contains 84.4 per cent of carbonate of lime. It is of good quality. Near the village of Strong, at the falls, may be seen ledges of blue sparry limestone, dipping to the north-east. It contains 90.5 per cent. of carbonate of lime. There are at least four different beds of limestone in New Sharon. They are blue or light blue, somewhat micaceous, and contain from 53.8 to 88.2 per cent. of carbonate of lime. That upon Mr. Bean's land contains 10 per cent. of the peroxide of iron. That in Jay is upon Mr. Noyes' land. It is white and highly crystalline, containing quartz and crystals of actynolite. The limestone in Industry is blue, micaceous, and contains a few crystals of calcite. It contains 76 per cent. of carbonate of lime.

In Somerset county beds of azoic limestone occur in the following towns: Norridgewock, Skowhegan, Starks, Palmyra, Harmony, Athens, New Portland, Bingham, Canaan, Lexington, and at the Forks of the Kennebec river in the wild lands. There are several good beds of limestone in Norridgewock. One upon the estate of S. Sylvester contains 88.2 per cent of carbonate of lime. It is traversed by sparry veins of calcite, and is of a light brown color. The beds in Norridgewock are all enclosed in clay slate, and they dip north-westerly. The limestones at Skowhegan Falls are bluish gray, and are a trifle more than half (53.8) of pure carbonate of lime. The lime burnt from it is of a brown color. The limestone of Harmony is slaty, of a bluish color, and contains 38.6 per cent. of impurities. Limestone occurs abundantly in Harmony on the Higgins stream, in beds from four to six feet thickness, interstratified with clay slate, and standing almost upon their edges.

In Athens there is an important bed of limestone on the east branch of the Wasseronset stream. It is grayish white, with 70.4 per cent. of carbonate of lime. A bluish compact limestone at Athens village gives 72.6 per cent. of carbonate of lime. Half a mile above Bingham at the saw mills, there is a bed of blue limestone, in which may be found small veins of galena and zinc blende. The limestone dips to the north-west and contains 42.6 per cent. of carbonate of lime. At the Forks of the Kennebec river in No. 1, R. 5, of Bingham's purchase, the rocks are all calcareous, and some portions contain 50 per cent of carbonate of lime. The strata consist of calciferous slates alternating with buff limestones from half an inch to a foot in thickness. The limestone in Lexington was found only in boulders, but the locality of the boulders cannot be far distant.

The limestones of Kennebec county are found in Vienna, Mount Vernon, Waterville, Belgrade, Winslow, Winthrop, Sidney, Hallowell and Clinton. In the south-west part of Vienna near the Chesterville line, are beds of limestone in mica schist. They are on the south side of the McGurdy river. They are two in number; the one nine and the other fifteen feet in width. Both dip to the north-west. A third bed is adjacent to them at Mr. Lyman Wheeler's house. A bed of limestone, grayish white and granular, is found in mica schist, dipping north-west, near Mr. James Chapman's, three quarters of a mile north-east of the village of Mount Vernon. It contains 48.8 per cent. of carbonate of lime. The lime manufactured from it is of a brown color. At Waterville narrow beds of yellow siliceous limestone are found in the clay slate near the bridge crossing the Kennebec river for the Kennebec and Portland Railroad. These are of little consequence. In West Waterville there is an important bed of limestone in argillo-micaceous slate 66 feet wide. It is upon Mr. Baxter Crowell's farm, and contains 89.8 per cent. of carbonate of lime. At the Falls in West Waterville there is more limestone of the same general quality, containing 73.8 per cent. of carbonate of lime. Still other localities of limestone are in West Waterville, but none as good as the ones just mentioned.

In Winslow there are several beds of limestone. That upon James Wall's land is of a light bluish gray color, traversed by small veins of calcite, and contains 73.8 per cent. of carbonate of lime. That upon S. Simpson's land is of a dull light gray color, mixed with slate, and contains 68.4 per cent. of carbonate of lime. That upon Mr. Drummond's land is better than the rest. It is blue, and contains 81.8 per cent. of carbonate of lime. On Mr. Furbur's land a limestone containing 77.8 per cent. of carbonate of lime is found. It is of a dark blue color. The limestone of Winthrop belongs to the calciferous mica schist and is of the same color with the interstratified rock. It contains 78.8 per cent. of carbonate of lime. Mr. Wm. Prescott of Sidney, has sent us large specimens of limestone from his farm; one of which is polished. It may be used for marble if obtained in sufficient amount, and it would form very durable marble. One of the specimens is on exhibition at the State House in Augusta. The limestone in Hallowell is contained in strata of gneiss. At Brown's corner in Clinton, quarries of a blue argillo-ferruginous limestone have been opened. Crystals of pyrites are abundant in it. The amount of carbonate of lime present is 54 per cent.

Another bed of limestone in Clinton is of better quality, containing 76.8 per cent. of carbonate of lime. At J. D. Burrell's there is a bluish gray limestone, of which 47.2 per cent. is pure carbonate of lime.

In Sagadahoc county there are beds of limestone in Phipsburg. This limestone is enclosed in gneiss, is more crystalline than that in the more northern counties, and contains foreign minerals, such as egeran and garnet. Several beds of it are found upon this promontory. The decay of the limestone in several places has produced caverns in the solid rock.

In Lincoln county the limestone is found in Dresden, Whitefield and Waldoborough. But Knox county is the great reservoir of limestone along the coast, in the towns of Appleton, Hope, Union, Warren, Camden, Thomaston and Rockland. We regret much that we cannot speak more definitely respecting the geological character and position of the limestones in the three last mentioned towns, as they form some of the most interesting deposits in the whole State. The limestone did not appear to us in these towns to be in the form of insulated beds, like those described in the western counties, but rather to form several distinct formations, or a single one repeated several times. The strata are generally highly inclined, so that the thickness of the deposit may be very great, though its topographical width is small. There seem to be three bands of the limestone in Thomaston, all having a northeasterly and south-westerly trend. The most important lies in the valley of Thomaston, extending from George's river to Tolman's pond, including the quarries at Blackington corner. It is said to be nearly a mile wide; but in consequence of the abundance of drift concealing the rocks it is difficult to be positive about its limits. Another belt of limestone, running parallel, is seen prominently at the State's Prison, and at the Meadow's quarries, extending to Jameson's point in Rockland. Most of the quarries in Thomaston and Rockland are upon this band. The third band of limestone is largely dolomitic, and is seen at the marsh near the West Keag river. All these beds are cut by trap dikes in various ways, and numerous specimens can be obtained, showing the influence of the melted trap upon the adjacent limestone. These dikes can be traced for a great distance frequently. The workmen think that the best limestone is found in the vicinity of the dikes.

The limestones of Thomaston and Rockland are generally of bluish-gray and gray colors. Most of them are nearly pure carbonate of lime, containing only two per cent. of impurities. The limestone at the marsh quarry is a good dolomite. The limestones are generally even bedded and lie in thick compact masses, much like marble. There are several qualities of the limestone known to the workmen, which produce different qualities of quicklime.

There seems to be an anticlinal axis in the limestone at the meadow's quarries, which perhaps may be traced through the whole belt of which they form a part. We found the inclinations there to vary from 72 degrees north-west to 60 degrees south-east. At the States Prison quarry the dip is 80 degrees south-east. At the marsh quarries the dip is 70 degrees north-west. At the Blackington corner quarries the measurements were north-west 65 degrees and to the south-east. These were all isolated observations. The geological position of the different kinds of rocks in these towns have not yet been explored systematically.

Whether the limestone of Camden joins directly with that in Rockland and Thomaston is doubtful, but its lithological characters are the same, and probably its geological position. Some disturbance of the strata may have severed the direct connection of the two, as it may be a repetition of the belt by an anticlinal or synclinal fold. The limestone is found at Goose river settlement and near the village of Camden, with a north-west and northerly inclination. The Lily Pond quarries furnish most of the lime manufactured at the river. The limestone there forms a cliff 30 feet high, near a small pond. We examined Mr. C. C. Smart's opening in the limestone half a mile south of the village of Camden, and found the layers dipping 26 degrees northerly. There appears to be a great thickness of limestone in Camden.

The other limestones in Knox county are in beds of an older formation, like those in the western counties. They are numerous and extensive in Warren, where the white crystalline rock has been used both for marble and the manufacture of lime. The principal beds belong to the different members of the Starrett family. On the western side of the St. George river on Mr. A. Starrett's estate, there are two beds of limestone in gneiss, the largest of which is twenty feet wide, dipping 70 degrees south-easterly. They are dolomitic, and contain crystals of galena and zinc blende. On the eastern side of this river upon Mr. A. Starrett's land, there is a similar bed of limestone, 99 feet wide, and 150 feet long, so far as exposed. The bed belonging to John Starrett is 122 feet wide, and has been uncovered for 220 feet. It is inclined 55 degrees south-east. On Benjamin Starrett's land there are two beds of limestone, one of which is 30 feet wide. The enclosing rocks and the position of these are similar to those of the previous example. On the high bank of the St. George river half a mile north-west from A. Starrett's bed, there is more limestone exposed. This cliff is 26 feet high, and the limestone is white with blue patches and veins. It stands nearly upon its edges, and may be traced laterally a quarter of a mile.

So favorably are the limestone beds of Union situated that they were thought formerly to rival those in Thomaston. Some of the beds produce blocks large enough to be wrought as marble. Among the principal ledges may be noticed the following: the Miller ledge, a bed of fine grayish white limestone, 29 feet wide, with a north-easterly trend; the Orchard quarry bed, west of the Miller ledge, from 7 to 12 feet wide, standing nearly perpendicular, and the Bullen ledge, south-east from the Orchard bed, which is really a handsome clouded gray marble. The bed is 52 feet wide and 1,100 feet long. It dips 65 degrees south-east. A mill has been placed near it for the purpose of sawing the rock into slabs of marble. A bed 924 feet long and 30 feet wide is found near Union Common upon the Bachelder estate. It is a grayish white limestone. Other beds occur upon Harden's ledge near the shores of a pond; one of which is 91 feet wide and 330 feet long. It has been intersected by a vein of granite.

There are twenty quarries of limestone in Hope. The limestones are generally bluish, sometimes white and granular. It closely resembles the Thomaston rock, and like that is abundantly traversed by trap dikes. Near the dikes the limestone is dolomitic.

In Waldo county, beds of limestone occur in Lincolnville, where an immense amount of quicklime is manufactured annually. In Hancock county limestone is found in Bluehill and Bucksport. There are several of them in Bluehill, enclosed in gneiss, and are 300 feet in width, but not of superior quality. They are too thoroughly metamorphic to be of economical value, otherwise than by their natural decomposition. Doubtless the exploration of the northern parts of Hancock county would bring to light other beds of limestone.

In Penobscot county beds of azoic limestone occur in Dexter, Hampden, Oldtown, Carroll, and in boulders upon the Penobscot river. Those in Dexter and Carroll are of great value. In Dexter the beds are numerous. One upon Mr. Crowell's land is blue, very extensive, with only 10 per cent. of impurities. It runs nearly east and west and dips 80 degrees southerly. Mr. Fish's limestone is similar to the preceding, but contains veins of calcite. 89.2 per cent. of it is carbonate of lime. Another blue compact limestone, containing 78.2 per cent. of carbonate of lime is found upon L. Pullen's farm. That on John Puffer's farm contains 84 per cent. of carbonate of lime. A few calciferous slates are interstratified with these beds, but the prevailing rock is clay slate. There is an extensive bed of limestone in Carroll, which is of great economical value. We found boulders of a beautiful azoic marble on the Penobscot river between Winn and No. 3. Their source cannot be far distant.

There is probably a large amount of azoic limestone in the wild lands in the north part of Washington county. A few small beds appear at Princeton, and rumors reached us of more important ones in the vicinity.

In Piscataquis county the azoic limestone appears in beds in Dover, Guilford, Abbot and Foxcroft. That at Dover is found upon the south side of the Piscataquis river. It is a bluish gray limestone, mixed with slate, calcite and quartz, and contains 70.6 per cent. of carbonate of lime. The lime manufactured from it is brown. The Foxcroft limestone is found at the Falls. It is light blue, containing 64.4 per cent. of impurities, such as calcite, pyrites and slate. A similar limestone from a cave near the river contains 48.8 per cent. of carbonate of lime. The Guilford limestone is in clay slate, and is of a dark blue color. It is interstratified with layers of slate, and is found abundantly one hundred rods north of the church, and also near a small Island in the Piscataquis river. It contains 84.8 per cent. of carbonate of lime. The Abbot limestone is similarly situated, is of a dull blue color and contains 74 per cent. of carbonate of lime. Beds of poor limestone are said to occur abundantly between Sebec and Brownville.

Most of the limestones of Aroostook county belong to the fossiliferous rocks, and will therefore be described elsewhere. So also we have passed by the description of fossiliferous limestones in other parts of the State. There are three localities of azoic limestone in Aroostook county worthy of notice. Perhaps the best of them is at Drew's mill, in New Limerick. The limestone is white, granular, thick-bedded, and is situated between trap dikes. Very likely its highly metamorphic condition and its position are due to the disturbing influences of the dikes. The bed is two rods or more wide, and is of unknown length, to be estimated in rods rather than feet, and perhaps miles. Numerous beds and nodular masses of beautiful pyrites abound in the limestone, which by decomposition have accumulated an immense of bed of bog iron ore. The second bed of azoic limestone is in No. 6, R. 5, about a mile and a half east of the Aroostook road, in the south part of the town. The third bed is in the north-east part of Golden Ridge, if we may believe the testimony of some timber explorers of that region.

CLAY SLATE.

Clay slate is a fine grained, fissile, highly indurated rock, splitting into plates by cleavage. The common writing slates of the schools are made of clay slate. The cleavage planes often cross the planes of deposition at various angles. The strata can generally be distinguished from them by means of parallel bands of different colors and textures traversing the rock. It is generally a dull blue, gray, green, or blackish color, sometimes brick red, striped and mottled.

We are at the outset met by a difficulty in assigning the proper place to the clay slate of Maine in the geological series. Most of the clay slate in the State is azoic; still there is a portion of it which contains fossils. The area occupied by the rock is immense, but the fossiliferous portion is quite limited in extent. We conclude, however, to describe the rock as azoic, in general, but to specify the fossiliferous portion in detail under its appropriate head. In this way we shall not seem to assume confidently that these rocks are all of the same age, nor will the provisional separation of the fossiliferous belt from the azoic strata express the conviction that the clay slate series ought to be divided into several formations. We want a thorough investigation of the stratigraphical relations and the scanty organic remains of the clay slates.

Among the metamorphic rocks along the coast south-east from Portland, patches of clay slate are occasionally seen, as in Biddeford, Saco and Scarborough. The latter case is worthy of notice upon the map. It was noticed by us to extend from the west line of Scarborough (on the Saco road) to a point beyond Dunstan corner. The strata run north-east and south-west and are nearly vertical.

The next deposit of clay slate is of immense extent. We will try to draw a line which shall enclose the area covered by it, including the fossiliferous bands. Beginning in the south-west part of Waterville, it proceeds thence into Winslow, and probably through Unity and Jackson, to the north part of Frankfort. On the east side of Penobscot river it appears in the north part of Bucksport, running down into the west part of Orland, where it is quite narrow. The line continues from Orland north-easterly through Orrington, Holden and Eddington. From this point it is not known whether the southern border line of the clay slate extends directly to Princeton, or whether it passes to Princeton around the west and north sides of Hancock county. The belt of clay slate in the northern part of Washington county is probably connected with the main deposit, but it must make the north-eastern termini of the slate fork shaped. The exact width of the slate at Princeton, etc., is given upon a section in another part of the report. After taking up the line again at No. 10, R. 3, in Washington county, we can carry it but a short distance on account of the unexplored region in the south part of Aroostook county. The slate, however, disappears before reaching Houlton. Upon the Aroostook road we can find the north-western side of the clay slate and carry it westerly. The western border is found in the village of Patten, where it lies side by side with talcose schist. It passes over towards the east branch of the Penobscot, then runs up the Seboois river to Godfrey's Falls, and crosses over to the west side of the East Branch of the Penobscot river at the Grand Falls. Thence it returns down the east branch to No. 2, when it runs over to the North Twin Lake. From thence it proceeds in a direct course to the south end of Moosehead Lake. From here it runs to the Forks of the Kennebec river. Changing its course it runs down the Kennebec (or perhaps to a point near Mt. Abraham) to Bingham: thence eastwardly to the vicinity of Parkman: thence south-westerly to Norridgewock, and south-easterly to Waterville, from whence we commenced to draw the line. Those who follow this line upon the map will perceive that a vast territory is enclosed by it, though of an exceedingly irregular shape. It includes all the settled portions of Piscataquis and most of Penobscot counties.

Much of the clay slate over this area is of a fissile and easily decomposing character, so that it is useless for economical purposes. In the north-eastern portions it is often more properly a fine grained sandstone, associated with layers of clay slate, and rarely of limestone. In Piscataquis county there is much limestone connected with the slate. The most valuable portion of the slate, or the variety called roofing slate, is in Piscataquis county, passing into the counties adjoining. The relations of the clay slate to the more thoroughly metamorphic rocks on the north-west and south sides is as yet unknown, except at two or three localities, which are of too little value to allow of generalization. Occasionally a mass of granite has protruded through the slate.

We give a few details respecting the occurrence and position of the slate at various localities. The strata on the west side of Penobscot river below Bangor are inclined to the north-west, and are underlaid at Frankfort by mica schist. The clay slate in south-east Bucksport and the west part of Orland forms an anticlinal axis, which is overlaid on both sides by hornblendic rocks—possibly metamorphosed clay slates.

The following observations of the strike and dip of the clay slates in Penobscot county were taken by Mr. Houghton during the past season: Brewer, strike north 50 degrees east, dip 27 degrees north-west. Orrington, north part, strike north 70 degrees east, dip from 50 to 70 degrees north-west. Further south, strike north 80 degrees east, dip 60 degrees northerly. Just north of the village of South Orrington, strike east and west, dip 75 degrees north. Argillo-micaceous slate from West Bangor to Carmel with the following positions:—In Bangor, near J. Eastman's, strike north 55 degrees east, dip 30 degrees north-west; in Hermon, at Craig's house, dip 60 degrees north-west; west of do., strike north 63 degrees east, dip 60 degrees north-west; at Hermon Centre, strike north 60 degrees east, dip 75 degrees north-west; at West Hermon, strike north 75 degrees east, dip 60 degrees north-west; at East Carmel, strike north 73 degrees east, dip 60 degrees north-west; further west, strike north 45 degrees east, strata vertical; at Carmel Centre, strike north 70 degrees east, dip 75 degrees southerly; at North Etna, strike north 70 degrees east, dip 70 degrees northerly, and also strata vertical. The common clay slates have the following positions: in the north-east corner of Plymouth, strike north 45 degrees east, dip 75 degrees south-east; in North-west Plymouth, strike north 55 degrees east, dip from 70 to 83 degrees south-east; in South Plymouth, strike north 70 degrees west, dip 45 degrees southerly; in North Dixmont, strike north 50 degrees east, dip 75 degrees south-east; also north 55 degrees east, 70 degrees south; at the Newburg line, dip 70 degrees north-west, and strike north 70 degrees east, dip 78 degrees north-west. In Hampden Centre the dip is 35 degrees north-west. Thus it is seen that the north-west dip is the most common for the slates near Bangor; but it is not the only one. The presence of axes will enable us to reduce greatly the supposed thickness of the slates.

This point is illustrated by examining our observations in a line crossing the clay slate from Patten to Bucksport. From Patten to a point three miles north of Molunkus village the dip is north-westerly. From thence to the Five Islands Hotel in Winn the dip is south-easterly. From this point to three-fourths of a mile below the village of Passadumkeag the dip is north-westerly again. From thence to the south part of Milford the dip is south-easterly. The strata for the rest of the distance to Bucksport probably dip north-westerly. But they dip south-easterly as they disappear in Orland. On this section there are then five axes—three anticlinals and two synclinals.

Some of the slates about Bangor are so thickly glazed with plumbago as to have been mistaken for coal. They are largely talcose, and are occasionally traversed by dikes. The following is the general structure of the formation between Bangor and Barnard.

At Bangor the dip is to the north-west. This changes soon to south-east, which continues to Charleston. There it changes again and dips north-west. This dip is not continued long for the rocks soon dip southeasterly, and do not change again till we arrive at a point two and a quarter miles north of the south line of Atkinson. Then the dip is to the north-west, which continues to Barnard. The character of the rock as far as Atkinson is very much like that of the strata in Bangor. The layers are often irregular, and are traversed by veins of quartz. Beyond Atkinson the strata planes are more regular and better adapted for quarrying. The strata at the quarries are nearly perpendicular, and incline northerly. The character of the rocks at Brownville and in the vicinity of the Katahdin Iron Works is essentially the same.

The rocks in Parkman are wholly clay slate, dipping to the south-east; so in Abbot, and on the whole route from Monson to Moosehead Lake. The most western portion of the clay slate that has been examined lies in the valley of Kennebec river, between Bingham and the Forks of the Kennebec. At the Forks the rocks consist of an alternation of calciferous and clay slates, with strata of fine grained sandstones. This must constitute the upper member of the clay slate series. All the strata on the Kennebec dip north-westerly at a high angle. The slate at Moscow is of good roofing slate quality, but that at Bingham is filled with veins of quartz, and is too much jointed to be of great value.

There is a belt of mica schist in the Kennebec valley separating the clay slate into two large prongs, running out from the main deposit. Passing by Solon and Madison, therefore, we find the clay slate again in Cornville, Norridgewock, Skowhegan, and thence to Waterville. The slate in Cornville is remarkably sound, and is interstratified with beds of argillaceous limestone from six to ten feet wide. Limestone is also found in connection with the slate at Skowhegan Falls. At Norridgewock Falls the clay slate is very hard and passes into mica schist and fine grained sandstone containing crystals of pyrites and specks of iron ore. The boulders of clay slate in Phillips are probably derived from another clay slate deposit to the north-west, which will presently be described. The slates in Dexter and Corinna dip southerly. Specimens of clay slate have been obtained from Mount Abraham and Farmington.

The next deposit of clay slate that we shall notice is of immense extent, but its details cannot be given as it lies almost wholly in the wild lands. It is seen first at its south-west development on the Megalloway river; next on the Canada road; next on the west branch of Penobscot river north of Moosehead Lake; next on the Alleguash river, whence it has been traced down on the St. John river as far as the north-east corner of the State, and up the St. Francis river to the Boundary Lake. We shall say more about it, as well as of the next deposit, in our special report upon the Geology of the Wild Lands.

In the north part of Grand or Matagamon Lake, and extending to Webster Creek, we found clay slates mixed with obscure slates and fine sandstones. They appear again at the Second Sebois Lakes and on some portions of the Aroostook river; also upon the Aroostook road in Nos. 8 and 9; and lastly in the vicinity of Castle Hill, in No. 12 of the third and fourth ranges. This range may connect with the larger one north of Castle Hill. As a whole, this is a very poorly characterized clay slate range.

A large proportion of the slates in the eastern part of Aroostook county are argillaceous. But as they are largely calcareous we prefer to describe them under a different head from either clay slate or limestone. They are undoubtedly fossiliferous.

QUARTZ ROCK AND ASSOCIATED CONGLOMERATES.

Quartz rock is essentially composed of quartz, either granular, arenaceous or hyaline. Varieties result from the intermixture of mica, feldspar, talc, hornblende or clay slate. When crystals of foreign minerals are present, they are often useful in enabling us to determine the position of the strata, which in pure quartz are often difficult to ascertain. It is both azoic and fossiliferous, in both of which forms it occurs in Maine. It is very common to find layers of quartz in schists or slates. In this case they are subordinate strata, and are not sufficiently abundant to be called rocks. Examples are in the talcose schist in the vicinity of Portland, and in the slates of Biddeford, Bangor and Anson.

The quartz rock of Liberty is really a part of the mica schist formation, and is not sufficiently wide spread to deserve a place upon the map. The rock is quite white and beautiful, greatly resembling dolomite. It occurs upon the land of Capt. B. E. Matthews in beds dipping south-easterly. The largest bed is eleven feet in thickness. Numerous smaller and quite irregular beds are common on the same farm.

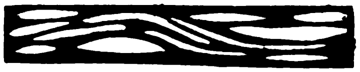
There is considerable quartz rock at the foot of Chesuncook Lake, and at the rapids between Chesuncook and Ripogenus Lakes.

Beds of quartz rock are associated with the limestones in Thomaston, Camden, etc. They are considered as Taconic by Prof. Emmons, and in another part of this report we have quoted from him some remarks concerning them. We have noticed in Thomaston two localities of quartz rock; one at the Marsh quarries on West Keag river, and the other almost in the village.

Near the village of Rockland, on the hill west, there are outcrops of nearly pure quartz rock, containing a little lime, and some slaty matters. The strike is north 28 degrees east, and the strata are both perpendicular and dip to the east. At Rockport also a beautiful quartz rock appears, dipping 40 degrees north. A semi-quartzose siliceous slate overlies it. Near Goose river, Prof. Emmons describes two masses of quartz rock. A conglomerate more or less related to the quartz composes the most of Megunticook mountain.

There is a narrow band of blue quartz rock in the south part of

No. 9, R. 5, of Aroostook county. A more important one is in Weston and the north border of Washington county. It is a belt four or five miles wide, and is composed of quartz rock, mica schist and a very peculiar conglomerate. In travelling northerly it is first seen above the middle of No. 9, the most northern town in Washington county, where the inclination is 65 degrees easterly, the strike being north 8 degrees west. The layers are sometimes contorted, showing evidences of metamorphic action, and numerous narrow perpendicular veins of quartz cross the strata. The pebbles were not seen in Weston, but in their stead a thick mass of blue quartz dipping 70 degrees southerly, or at right angles to the previous position. The peculiarity of the conglomerate consists of the distortion and the curvature of the pebbles. Their general appearance may be illustrated by the accompanying figure. The pebbles appear as if they had been drawn out, curved and pressed together by the various forces to which they have been subjected. As this subject is a new one, illustrating many features of metamorphism, we feel called upon to enlarge somewhat upon it, and shall not confine ourselves to what may be learned from this instance.



ELONGATED PEBBLES.

We take two positions which we think can be maintained. First, the pebbles of this and similar conglomerates have been elongated, flattened and curved since their consolidation into rock. Second, the elongated pebbles have been changed into the siliceous laminæ of talcose and micaceous schists, while the cement has been converted into mica, the talc of talcose schists, and feldspar. To effect the first change requires that the materials be in a yielding state like moistened clay, and the application of force or pressure. To effect the second change requires the action of chemical forces among the heterogeneous sedimentary materials, selecting and combining the atoms in their proper proportions to form the new crystalline masses.

Now what is the normal arrangement of the pebbles in a conglomerate? Let any one examine the pebbles upon a beach, the coarse gravel in drift, or the ordinary sedimentary conglomerates even of the older rocks, such as the red conglomerates in Perry, Lubec, or at the Grand Falls of the east branch of the Penobscot, and he will find them all agreeing in composition. The pebbles are mostly smooth and rounded, very rarely elongated or flattened except where the pebbles are fragments of slaty rocks, rarely bent unless a fragment of a curved stratum, and never with long pebbles arranged parallel to one another. We do not think a case can be found where the pebbles naturally assume a position similar to that which they have assumed in the case figured above. The section crosses the strata at right angles so as to show the pebbles drawn out and flattened. The cut shows only a section of the flattening. The general shape of the pebble will be understood by comparing it to a piece of plastic clay wrought under peculiar circumstances. Let any one take a sphere of clay and pull it out so as to form a prolate spheroid. If the original lump was three inches in diameter the spheroid may be six inches long and less than two inches in width and thickness. Let now this spheroid be compressed between two books, and the result will be an elliptical shaped flattened plate. Suppose this plate stiff enough to remain bent when force has been applied to it, and we shall have the exact shape of many of these pebbles. The pressure of an immense weight would elongate a pebble of clay to several times its original length, but it would be very thin, and would thus resemble a lamina of quartz in gneiss.

Suppose now that instead of one ball of clay several were used, some of them being plastic and others hard; and conceive of a force that shall pull out all the plastic ones and flatten them. The result will be that the plastic balls will have their forms modified by the unyielding ones, so that a plastic piece will fold partly around the hard pebble, perhaps fitting upon it like a cap upon a human head. We find among the distorted pebbles cases of this nature. Some pebbles have been more plastic than others, and the results are indentations of the harder into the softer ones, curves around the hard ones, or the fitting of one into another like a ball in its socket. Or the ends of the elongated pebbles may only fit upon each other to economize space, as it were, as in the figure above.

A typical example of the first stage of the distortion of pebbles may be seen near Newport, R. I. The rock is the Lower Carboniferous Conglomerate, which at the Alms House, north of the city, may be seen in its normal character of rather a loosely cemented mass of cobble stones, commonly from an inch to six inches in diameter, all rounded or spheroidal. There is very little cementing material, scarcely enough to hold the pebbles together. Indeed the force of the hand is often sufficient to remove one pebble from the mass. The mass is strikingly like a hill of clean coarse drift. Now if the explorer travels a couple of miles south-easterly to what is called Purgatory, he will find another conglomerate nearly of the same age, but wonderfully different in respect to the shape of the pebbles, in the following particulars: 1. They are often much elongated in the direction of the strike. 2. They are flattened, but not so strikingly as they are elongated. 3. They are indented, often deeply, by one being pressed into another. 4. They are sometimes a good deal bent, occasionally in two directions; and 5. They are cut across by parallel joints or fissures, varying in distance from one another from one or two inches to many feet. But no one can doubt the conglomerate character of these ledges, even though he may not account for the elongation of the pebbles in the same way with us. The meagre cement of these pebbles is an obscure talcose schist, containing crystals of magnetite, still the pebbles adhere firmly together; they cannot be drawn out by the hand.

The conglomerate range at Purgatory is seen further to be divided by great fissures or parallel joints. The most distinct are perpendicular to the horizon, and make a clean cut from top to bottom of the hills of conglomerate, from thirty to forty feet high, as if a Titan had slashed his scimitar through the mass. These joints cut right through the pebbles, just as they do through the cement. Abrading agencies have often removed the rock on one side of these joints, or between two of them, so as to leave walls of pebbles smoothly cut in two; the whole appearing like a pile of fire wood where the sawed ends only of the sticks are seen. These cut surfaces are often glazed, as it were, and do not exhibit the polish which would arise from friction. The pebbles upon the opposite sides of a fissure always correspond to each other; half the pebble may be on one side and half on the other side. Rarely a pebble remains entire, one part projecting from the smooth perpendicular surface, but in such case a slight blow would instantly sever the projection; for a seam passes through the pebble along the line of the fissure.

The observer of these two localities will at once conclude that the pebbles in the Purgatory conglomerate were once in the same condition with those at the Alms House. This conclusion is almost irresistible; he can almost see the work going on. He may inquire why some of the pebbles should have been changed and others not. Then he may find some evidence by examining the position of the strata. Those at the Alms House are nearly horizontal or but slightly inclined, having always been in the same undisturbed position since their deposition. There have been no openings to allow the escape of heat and vaporous matters from beneath. But at Purgatory the case is different. He finds there and near by a series of sharp curves, and discovers that the change in the pebbles has taken place only where there was abundant access to calorific influences from beneath.

It seems to us very clear that the pebbles must have been in a plastic condition in order to have passed through such changes. No other supposition can account for the indentures, the neatly fitting of the pebbles into one dense mass and the bending of some portions. Any attempt to change the form of the Alms House conglomerate in its present unyielding state would only result in fracture and comminution. There is no other way to account for the bending except by the original shape of the pebbles, and their accidental arrangement, a supposition which holds good in no bed of pebbles now forming.

The character of the cementing material argues some peculiar condition of the conglomerate, such as would be found in plasticity. The original grains of sand have become schists, and are sometimes firmly pressed into the substance of the pebble, so that a blow will not separate the schist and pebble along the line of junction. The rock has been in such a state that chemical forces could easily select the proper atoms from the particles and combine them into crystals. Both the crystalline character of the cement and its firm adhesion to the pebbles, are absent from the conglomerate at the Alms House.

The existence of the joints is an argument for plasticity. The glazed surfaces of the cuts do not result from the breaking of the strata and the subsequent friction of the surfaces upon each other. Besides the character of the surface, the frequency of the joints forbids that supposition. They must have been produced in the same way in which joints have been made in schists and slates. The rock must be so far plastic that galvanic currents can have free play through the mass, and be allowed to split it up according to its own rules of operation.

The second part of the process is the elongation, flattening and bending of the pebbles. Where is the force that can have produced these results, granting the plasticity? We can refer only to that force which from the very first geological period has been crowding against the rocks along the shores of the Atlantic Ocean from the south-east. It is the force which has folded up the strata into great curves, so strikingly exemplified in Maine and elsewhere, particularly in the numerous curves in the conglomerate under consideration. It would seem as if the pulling of a plastic mass as it curves over a subjacent rock would stretch out portions of it, while the great pressure of the ocean or other strata above, would flatten the layers and crowd the whole into the smallest compass possible. This would account for the pulling out and flattening of the pebbles in the line of the dip. The force must be exerted by some other kind of tension where the elongation is along the line of strike, as in Newport. The bending and indentation of the pebbles must be due to minor causes. A flattened pebble will bend around one not flattened, and small flexures of the strata will contain pebbles bent at the same angle. We have seen them bent nearly double.

Let us see whether the example of distorted conglomerate in Maine will conduct us to our second position. The general phenomena are the same as those at Newport—the pebbles are elongated, bent around one another, indented and rarely cut through by joints. Whether the elongation was in the direction of the strike, or the dip, we do not remember. One of the pebbles is two feet and three inches in length, and three inches wide. The rocks also bear testimony to the presence of heat and plication. Numerous small veins of quartz fill up the cross-cut joints, and local plications are frequent. The marks of great pressure are very evident.

But in two important respects the Maine example differs from that in Rhode Island. The cement is more abundant and the pebbles are hyaline. The whole rock has been changed into mica schist, so much so that a few years ago we should have called the whole mica schist, and have overlooked the pebbles. Hence we have here a striking case of the change of a sedimentary into a crystalline rock. As before, having ascertained the fact, we must now endeavor to explain some portion or the whole of the process; and this effort will be in support of our second proposition.

If the original sandstone and the resulting mica schist were taken separately, pulverized, and the powder analyzed, it would be found that the atomic constituents are the same in both parcels.

Granting the plasticity the explanation of the change is easy. The atoms mechanically mingled were thus enabled to choose their proper places in the new compound by the laws of chemical affinity. Thus grains of sand have formed themselves into laminæ of mica and quartz, or mica schist.

But the examination of other portions of the original sandstone or conglomerate results differently. The schist contains a greater per cent. of certain elements than the original sandstone. There are two ways in which this change may have been effected. First, the plastic mass may have been penetrated by waters holding chemical agents in solution. The laws of affinity call the atoms from the solution to unite with other atoms of the sandstone. Hence the resultant contains more lime perhaps than the original stone. Or secondly, the character of the larger pebbles may have been changed—particles may have been abstracted from them just as they were from the water, and united with the particles of the cement as before. Possibly both the alkaline or carbonated water was present, and the larger pebbles gave up part of their substance. It is easy to see how very complicated the results might be from the combination of infiltrated matters with the extraction of soluble compounds from the pebbles. We may be satisfied at present with this expose of the general principle of the change. We need not stop now to inquire whether it was the silicate of an alkali, the carbonate of an alkali, or carbonic acid, or silicic acid, that was the principal agent in the metamorphosis. We have traced out the fact of the change, and feel satisfied that what was once conglomerate is now talcose or mica schist. And if a few imperfect schists thus disclose their original condition, what is to hinder us from supposing that the thoroughly metamorphic schists have been formed in a similar way?

We stated that the chemical constitution of the pebbles may have been changed without the essential alteration of the mechanical structure of the rock. As the pebble is now constituted, there is no natural agent short of igneous fusion which could change its form. It is composed of pure silica, and nothing but hydrofluoric acid will act upon it, and that is not found in nature. Silica by itself is more insoluble and infusible than any other part of the rock;

but in combination with other substances it may be easily acted upon. Then the distortion of a pure hyaline quartz proves that its distortion was produced when some other substances were combined with the silica. If we look at the character of the Newport pebbles we find that they are not pure silica, though homogeneous in structure. They are silicates of alumina, lime or iron. The silicates are soluble in alkaline waters. Hence a part of the pebbles may be dissolved out, leaving a residuum of pure silica in the distorted form in which the pebble was left by the pressure exerted upon it when compound. It is very clear that a pure quartz pebble must always retain its original form.

Now if the silicates are soluble why is not the whole pebble dissolved, or why is not the form of the pebble destroyed by the abstraction of a portion of the mass? Both these changes may happen we conceive. But the whole of every pebble cannot be dissolved, or the whole sedimentary strata had long since disappeared. There may have been an excess of silica in the pebble. That pebbles should have been compressed into a smaller compass after portions of them had been removed is perfectly reasonable. The whole stratum may not have diminished in thickness, because the removed particles may have entered into new combinations. Nor is there any objection to the supposition that strata may shrink somewhat during the metamorphic process.

Perhaps we may find conglomeratic rocks in Maine which will show that the mineral constitution of pebbles may be changed without destroying their character as pebbles. The typical examples are found in the Connecticut River Valley in Massachusetts and Vermont, but similar rocks are found in Maine, particularly at the North-east Harbor in Eden. The rock may be defined as a conglomerate with a syenitic or granitic cement, or as a granitic or syenitic rock containing pebbles more or less abundantly. The rocks at North-east Harbor are mostly syenite. In Jackson's First Report upon the Geology of Maine, page 46, a sketch is given of this syenite containing numerous fragments of talcose and micaceous schists and clay slates, the pebbles being very little rounded, the whole forming a very curious rock. According to the former views of geologists it would be said at once that the syenite was mixed with a mass of pebbles, or that it caught them in its fiery current when fragments of the adjacent ledges were broken off. According to the more recent views it would be said that the syenitic cement was formed from the matrix of the conglomerate, and that the included pebbles of schist had also been changed from their original clayey or siliceous character, yet preserving essentially their original shapes. We cannot here go into the details of this subject.

We need add only a word to complete the establishment of our second proposition, to show that the pebbles of conglomerates may become themselves the siliceous laminæ of schists. We have shown partially how metamorphism renders pebbles hyaline, and how a spheroidal pebble may be flattened and distorted. When plastic suppose the pressure to have been very great. This will expand the pebbles so that they may form thin layers resembling strata, and they will, of course, lie in the planes of stratification. Large pebbles may be flattened, like those in the figure above, so as to be several feet in length. Let any one examine a series of these flattened pebbles, where a lateral joint has cut through the ledge, alternating with layers of mica and mica schist, and he would at once pronounce the rock mica schist. On the edge of the rock he sees only those alternating layers of crystalline masses that he has never seen except in mica schist. Often the pebbly character is very obscure, and one not conversant with the facts stated above would not doubt the schistose character of the rock. Let this flattening process be carried on further, and no one will be able to trace out the original pebbles and the original cement. All have been completely changed. We feel satisfied then that sandstones and conglomerates may thus be changed into mica schist, talcose schist, and gneiss—the latter transition having been observed in Vermont. We do not say that all the schistose rocks have been formed of these two materials. There is evidence that clay slate may be also converted into schists.

It may be then that all the schists in Maine were once sedimentary rocks. To trace out the steps of their metamorphosis, and to learn the periods of their original deposition will afford a difficult yet pleasing task to those who shall further elucidate the geology of Maine.

METAMORPHIC SLATES, ETC.

Under this head we include a variety of hornstones, jaspers and siliceous states, which are almost always local alterations; so evidently metamorphic that their passage from the altered to the unaltered rocks is very easily seen. They are most commonly seen in the vicinity of such igneous or aqueo-igneous rocks as trap and granite, and were doubtless altered by the heat exerted in the production of the traps and granite acting upon the original slates and sandstones.

The largest mass of these metamorphic slates is in the south part of Washington county, adjacent to the largest amount of trap found any where in New England. In fact the trap and slates appear to pass into each other insensibly, just as if the trap was composed of fused stratified rocks. The most western part of the main land underlaid by these altered rocks is the Point of Maine or Machiasport. Very likely some of the islands in Mason's bay and those off Jonesport are composed of similar materials. One of them, which is sometimes called Great Island, is principally composed of a highly metamorphic sandstone, so changed that it is difficult to recognize it. It is overlaid by a mass of trap rock, and is almost as hard as porphyry.

We made a careful examination of the west shore of Machiasport, beginning at the Point of Maine, and will give the details here, at the risk of being somewhat tedious. Nevertheless many similar examinations must be made before the rocks of Maine can be properly classified. The specimens illustrating every point of the section may be seen at the Natural History Rooms in Portland, where the catalogue gives more details than are here presented.

The rocks at the extreme Point of Maine are trap and gray calcareous sandstone, probably of Upper Silurian age. Soon we come to the Red Sandstone, which is the continuation of that at Starboard's creek. With this there are a few small beds of indurated sandstones, jaspery conglomerates and jaspers associated. These rocks dip northerly and north-westerly, and apparently underlie an immense amount of jasper, lying to the northward. At the point of junction there are trap dikes, and the strata bear marks of a considerable disturbance. This spot is less than a quarter of a mile from the extreme Point of Maine.

a. The first member of the metamorphic series is a jaspery conglomerate, with its strata distinctly marked by bands of different colors and dipping 40 degrees west.

b. Next is a dark colored jasper, with the strike north 15 degrees west, and the dip 17 degrees east.

c. Next is a mass of jasper easily weathering.

d. Then we arrive at an immense bed of brecciated jasper, the fragments composing the breccia being themselves jasper. One of the fragments measured 22 inches in length.

e. Some layers of pure jasper rather to the south of the breccia run north 10 deg. east, and stand upon their edges.

f. In *c* and *d* we counted nine trap dikes, some of them occasionally dividing into several branches.

g Sixteen dikes of trap in jasper.

h. Jasper, with the strike north 70 degrees east, and the dip 75 degrees north-westerly. This mass is most beautifully divided by jointed planes.

i. Two dikes of trap—one two feet wide, running north 80 degrees east, and dipping 65 degrees south-easterly; the other seven feet wide.

j. Jasper, with the strike north 80 degrees east, and the dip 25 degrees south-easterly.

k. Jasper, with the strike north 48 degrees west, and the dip 20 degrees north-easterly.

l. Dike of trap, vertical, and running north 80 degrees west.

m. Jasper eight feet thick, running north 58 degrees west, dipping 27 degrees north-easterly.

n. Dike of trap, four feet three inches wide, and running north 25 degrees west.

o. Jasper forty feet thick, with same position as *m*; thirty-five feet thickness above dip 45 degrees east. Here the strata begin to exhibit themselves in most delicate curves, which are all inverted, and consist of both minute anticlinals and synclinals. Passing by thirty-three feet more of the jasper strata we come to a mixture of small trap dikes and layers of jasper, as follows: Trap twenty inches thick, jasper ten inches, trap two inches, jasper eight inches, trap two inches, and jasper thirty-four inches. The total thickness of the jasper in *o* is 108 feet.

p. Next are the following alternations on the section: trap dike twenty-two inches, jasper twenty-four inches, trap dike forty inches, and twelve feet of jasper.

q. Dike of trap, twenty-four feet wide, containing large and small fragments of jasper in its mass, with the strike north 20 degrees west, and an easterly inclination of 75 degrees.

r. Jasper fourteen feet thick, with the strike north 80 degrees east, and the dip of 18 degrees southerly. A trap dike two feet wide and containing epidotic masses crosses through *r*.

We commenced this section in the hope of ascertaining the exact thickness of every bed of jasper and every other rock found upon it, but were compelled to give up the plan on account of the great difficulty in tracing out the continuity of the jasper bed. For instance at *r* the jasper begins to change its position and there is nothing distinctive in the character of the rock to show us when we have gone over the repetition of the same strata already examined and have arrived at new layers, or those overlying *r*. But we will continue to record the character of the rocks as we found them in proceeding north. The rocks are exceedingly beautiful along the whole coast. The jasper is mostly of a blood red color weathering brownish red.

s. Dike of trap several rods wide.

t. Jasper, dip 18 degrees southerly.

u. Three dikes of trap, two feet, eighteen feet and twenty-four feet wide respectively. The last two are separated by jasper eight feet in thickness, but by a much greater topographical distance. The thicknesses given in all cases are stratigraphical, unless otherwise specified.

v. Jasper, dipping 10 degrees south-east.

w. Dikes of trap mostly for the next ninety feet topographically.

x. Black Jasper or hornstone in great abundance.

y. Six very wide dikes of trap, the last of which is filled with dark nodular masses; the others being of uniform texture. Some of the Jasper between the dike is much indurated.

z. Jasper, dipping 20 degrees north-west.

aa. Dike of trap thirteen feet wide, running north 10 degrees west, and dipping 65 degrees easterly.

bb. Black jasper or hornstone.

cc. Curving dike of trap, four feet wide.

dd. Jasper, with same position as *z.*

ee. Dike of trap four feet wide. On each side of it there is a thickness of two feet semi-trappean rock, easily worn out by the waves of the bay.

ff. Jasper, both red and black, the latter predominating.

gg. Dike of trap eight and a half feet thick.

hh. Indurated jasper, running north 10 degrees west, and dipping 75 degrees easterly.

ii. Five dikes of trap. The last is fourteen wide, and many of them are traversed by veins and nodular masses of epidote.

jj. Black jasper, running north 80 degrees east, dipping 85 degrees southerly.

kk. Two dikes of trap, each from one to two feet thick, and both extending parallel to each other for a distance of five rods.

ll. After passing a beach twelve rods in length, where the rocks are entirely concealed from view, we come to jasper running north 85 degrees east, dipping 9 degrees north-westerly.

mm. Dike of trap seven feet wide, running north 8 degrees west.

We are now brought in the section to a point on the west coast of Machiasport, nearly due west of the United States Coast Survey Station, near Hazard's bay. The rest of the section was passed over very hastily. The jaspery and trap rocks were traced to the south headland of Kennebec bay. No trap was seen north of this point. At Johnson's point the rocks are indurated sandstones and conglomerates—the pebbles being mostly composed of jasper. About two miles north of Johnson's point, near Captain Moore's house, the rocks consist of indurated slates and red sandstones dipping from 55 to 60 degrees northerly.

We have found it extremely difficult to give a general lithological name to the metamorphic slates in Washington county. At different localities we can say jasper, hornstone, chert, siliceous slate and quartz rock, but each variety merges into one of the others. Almost universally the surface of the ledges, where the weather acts upon them, presents the most unpromising appearance imaginable to the geologists' eye. There is no general structural character visible, and the decomposition has extended so far into the ledges to make it uncertain with what variety of rock the ledge must be classed. The rough ledges in many respects are like trap. It is very curious that when these rocks crop out on the sea-shore their exact lithological character and stratigraphical position can be easily ascertained. The waves seem to prevent the air decomposition and keep the surface smooth. Even the drift striæ are preserved where the waves wash over the rocks, but when exposed on the high land nothing but the general stoss and lee sides are left of the effects of the drift agency. We shall therefore recommend to all future explorers of these rocks to examine them carefully along the coast. The whole shore should be examined as carefully as the portion already remarked upon.

Flint Island is really the south-western end of this metamorphic belt, but as the rocks there are sparingly fossiliferous they will be described in another part of the report. The Islands between Flint Island and Machias have never been explored. Nearly the whole of Machiasport is composed of these metamorphic rocks. The western edge of the flinty rocks, separating them from granite, probably begins in the extreme eastern part of Jonesborough, runs through Whitneyville, Machias, Marshfield (a mile and a half from Machias Centre), the north part of East Machias and the west part of Charlotte to Passamaquoddy bay in the south part of Robbinston. Almost all the stratified rocks southeast of this line are more or less altered. We must separate from it the small fossiliferous basin of Silurian and Devonian rocks occupying the schists of the irregular bay west of Eastport. It is probable that this is an artificial separation, for the altered rocks may have been the same with the fossiliferous strata originally.

Metamorphic slates abound in Cutler, Whitney, Marion and Edmunds. In the south-west part of Cutler the washing of the waves discloses distinctly the slaty character of the mass. It is more or less clearly shown in Edmunds where the tide sets back from Eastport. Similar rocks appear in Dennysville. There is often little soil over these hard rocks, and the effect produced by the great naked rough ledges upon the mind is that of a dreary inhospitable country suited for the wild beasts of the forest. A part of this region is uninhabited. The belt of metamorphic slates diminishes in width very rapidly east of Dennysville, and may run to a point before reaching Passamaquoddy bay. Yet the influence of the metamorphic agency is very obvious in certain layers, as over a large part of Pembroke, and upon Pigeon Hill in Perry The semi-metamorphic rock in the western part of Charlotte yields fossils sparingly; and it is thought that fossils may exist in the indurated rocks around Boyden Lake in the south-east part of the town.

These flinty slates appear upon the islands in Penobscot bay to some extent, in rocks of different age from those in Washington county. They have been noticed upon Deer Isle, Little Deer Isle at its southern portion, Vinalhaven and Western Island.

In York county these metamorphic rocks are abundant in the form of siliceous slates. It is difficult to define this rock in scientific terms so that it will be readily distinguished, so we will describe it as it appears. If one will imagine how common clay slate would look when it has been melted, so that no planes of stratification or cleavage remain, and so that the resulting mass is a little heavier and tougher than the original rock, he will know what siliceous slate is. It is a perfectly homogeneous slate rock without divisional planes. We have examined this rock in Saco and Biddeford, especially along the west side of Saco river to its mouth. Granite approaches very near the river, so that the slate band is exceedingly narrow. There is a little siliceous slate at Kittery Point.

Mr. George L. Goodale has represented four patches of siliceous slate on his map of York county, viz: one in the west part of Saco, running into Scarborough; a small one in the west part of Wells; quite a large one in Waterborough, passing nearly through Shapleigh; and in Buxton, extending into Gorham. Five deposits are also given by him in his map of Oxford county, viz: in the north part of Waterford; in the east part of Stow; in the north-east part of Mason; in Bethel, and in the eastern edge of Grafton. Patches of siliceous slate may be found also in Bristol, Salem, Phillips, Avon, and at Piscataquis Falls.

There are interesting bands of jasper, hornstone and the siliceous slates in the wild lands, particularly upon Moosehead Lake, about Lunksoos mountain and Grand Lake upon the east branch of the Penobscot river, upon the Aroostook river above Masardis, and above Chamberlain Lake. They will be described in our special report upon the wild lands.

UNSTRATIFIED ROCKS.

The general character and classification of the Unstratified Rocks has already been given. Those in Maine belong to the Granitic and Trappean groups, and are all much older than the Volcanic rocks. The name *Igneous* is used instead of Unstratified by many of the best geological writers, as it is generally conceded that these rocks were all produced by igneous or aqueo-igneous agency.

The first condition of many of the igneous rocks, such as trap and porphyry, is supposed to have been similar to that of the lava which flows from volcanoes at the present day. Lava, when cooled rapidly, and not under pressure, forms glass or scoria; but when cooled slowly and under pressure, it becomes crystalline. Hence it is supposed that many of the older igneous rocks may have been once like lava, but have become crystalline under great pressure.

We cannot determine the age of the unstratified rocks except by comparing them with the stratified rocks displaced by them. If a Silurian formation has been cut through by a mass of trap, it is plain that the trap was protruded subsequently to the period of the deposition of the stratified rock, but whether it was protruded in the Devonian, Carboniferous or later periods must be determined by other facts. Sometimes a Devonian rock may be adjacent to the Silurian bed, and some of the Devonian pebbles will be found to have been derived from the trap. In this case the age of the trap may be considered as intermediate between the Silurian and Devonian periods; its eruption may have been one effect of the change of level which ushered in the Devonian system of life and action.

In general the granitic rocks are older than the trappean; but no rule can be laid down, for trap is found as early as granite, and granite has displaced strata as recently as trap, viz., as late as the tertiary period.

GRANITE.

Granite is a compound rock, being a crystalline aggregate of quartz, feldspar and mica. Its prevailing color is whitish and flesh-colored. The materials vary greatly in their size in different localities. In some cases the crystalline fragments are very coarse, being a foot or more in diameter. In other cases they are so fine as to be scarcely visible. Between these extremes there is almost an infinite variety of texture.

Granite is *porphyritic* when it contains distinct crystals of feldspar, generally quite large. When the ingredients are blended into a finely granular mass, with imbedded crystals of quartz and mica, it is called *Eurite*. *Graphic granite* or *Pegmatite* is composed of quartz and feldspar, in which the former is arranged so as to make the surface of the rock exhibit the appearance of letters, such as make up the Ethiopic or old Greek Alphabet. Granite is said to be *tabular or regularly jointed*, when joints or its intermixture with slates divide it into large tables and prisms of various sizes. These varieties all occur in Maine.

Owing to the progress of knowledge the old mineral species feldspar and mica are now subdivided into several, according to their chemical composition. We have now the potash feldspar, the soda feldspar, the lime feldspar, and several kinds of mica. Ultimately it will be necessary to give a special name to the granite containing orthoclase, (potash feldspar,) to distinguish it from the granite containing albite, (soda feldspar.) We shall have little occasion for these names in Maine at present, as most of her granites are of the same kind, the orthoclase granite.

There is an immense amount of granite in Maine. It is the prevailing rock in Oxford and York counties, according to the observations of Dr. Holmes the past summer. In the counties adjoining Kennebec river, numerous patches of greater or less size, are abundant. Immense ranges of it traverse Hancock and Washington counties. The Katahdin region is also granitic. Besides the great ranges numerous smaller masses of granite, often of an oval shape, as protracted upon a map, are seen in every county. Sometimes the granite is eruptive, or forms the substratum of an anticlinal axis, and again it seems to be included between stratified rocks, conforming itself to the strata above and below as though it were itself stratified. Or it may exist in the form of veins.

The Granite of the Four Western Counties.

The prevailing rock in York and Oxford counties is granite. In Cumberland and Franklin it is common but less abundant. Small patches of mica schist, gneiss and siliceous slate are found in the granite region, which have already been noticed. It seems almost astonishing to find so large an area almost exclusively occupied by granite; and one cannot help believing fully in the production of granite by the aqueo-igneous fusion of stratified rocks, when he notices its vast extent and intermixture with bands of stratified rocks, and also the general absence of anything like eruptive masses. This granite generally comports itself like a stratified rock.

In Biddeford there are quarries of granite of a beautiful color and texture. The granite appears upon the west side of Saco river, and extends to Kittery Point. Only a very narrow strip of slate separates it from the river, and there is likewise along most of the sea-coast an interrupted bed of slate. The latter seems to rest upon the granite. The boundary line between them may be drawn with great distinctness. Some of the Biddeford granite is very dark, owing to the presence of much black mica. This stone is the tabular variety of granite, as it splits into large sheets from one to four feet in thickness, and dips north-west 55 degrees. A few veins of white granite ocaasionally run through the tables, and in some parts of the stone there are patches of feldspar.

At the Ocean Quarry in Kennebunk, the granite is dark colored, owing to black mica, which is well mixed with a hard feldspar. The granite at the United States quarry is similar. Its feldspar is remarkably fine and translucent, with a fracture like that of glass. The quartz is not so abundant as the feldspar and mica. The fineness of the feldspar gives the same durable quality to the whole rock. A few minerals, as sphene, rutile and pyrites, are scattered through the rock in minute crystals. It is cut through by a trap dike, six feet wide, which easily decomposes. There are many other similar ledges of granite in Kennebunk, some of which contain flesh-colored instead of white feldspar. In a quarry in Biddeford we noticed several black spots in the granite, which are so common in many granites, composed of nodular hornblendic masses. They very much resemble pebbles altered by metamorphic action; and are, perhaps, to be referred to as this their most probable origin.

The boulders of granite in the western part of York county are numerous. Between Lebanon and Acton the granite in places is of quite a coarse variety. In Newfield, Davis' mountain is composed of granite, and gneiss is found upon its sides, containing beds of limestone. Bond's mountain is also composed of granite, in which are dikes of trap and veins of arsenical iron. In passing from Parsonsfield to Denmark and Waterford, the scenery is picturesque, owing to mountains of curious shapes. Many of the peaks are sharp; others are more rounded; and between Hiram and Denmark the traveller sees to the north-west a curious assemblage of conical peaks. These are all composed of granite. In Waterford there is granite of a beautiful light color, splitting readily into any desired shape, and is perfectly free from impurities. Hawk's mountain in Waterford is made up of granite, upon which there is a very high precipice, cut through by a trap dike. The dike can easily be seen from the road passing beneath.

Upon the outskirts of the great masses of granite, even at a distance of several miles from the main ledges, we often see immense veins of granite crossing strata of mica schist, etc. One such at Windham, on Col. Edward Anderson's farm, runs north 7 degrees east, and contains several minerals, such as graphite, tourmaline and beryl. An excavation was made in it formerly in the hope of finding silver. It is crossed by a trap dike twenty-six inches wide. A larger granite vein appears in the north part of the town. Boulders of granite in the vicinity contain the rare mineral spodumene. Soon after entering Standish, along the south-east shore of Great Sebago Lake, the schist has entirely disappeared, and only granite appears. It is of rather a hard and coarse variety. The boundary between the slate and granite runs nearly parallel from the lake, about a mile distant from the shore.

From Saccarappa into the south-east part of Windham there is a display of granite ledges for at least four miles, including Canada Hill and Walnut Hill. Whether it extends further is unknown to us. On these two hills the rock is of the ordinary light color and the common texture. Near Saccarappa, as it disappears, it is nearly black, very hard, and of compact texture, approximating to the trappean rocks in structure.

The granite rocks in Oxford county contain many beautiful minerals, as beryl, black, green, red and blue tourmalines, rose quartz, lepidolite, mica, feldspar, garnets, transparent and smoky quartz. From Paris have been obtained some of the finest tourmalines in any collections in the world. Such specimens are in the hands of Prof. C. U. Shepard of Amherst College, whose mineralogical inclinations were confirmed by the finding of these specimens, so that he devoted himself to the science of mineralogy, and now stands in the front ranks of American mineralogists. The original discoverer of this Paris locality was Dr. E. Holmes. The locality is upon Mount Mica.

Streaked mountain, 1756 feet above the ocean, is composed of a coarse variety of granite, underlying a gneiss anticlinal. This seems to have been an eruptive mass of granite, as the evidence of forcible eruption is manifest. The granite of Buckfield is mostly in the form of large beds and veins. Large crystals of garnets are scattered through them. The beautiful high mountains of Hebron and Peru are composed of granite. Woodstock is also mostly underlaid by granite rocks, traversed by a few dikes of trap. In one part of the town mica schist is found underlying granite. The rocks over which the Androscoggin falls, in Rumford, are granite. Granite has been observed in Dixfield, in connection with gneiss. Granite occurs near Frye's Falls, in Andover Surplus. In general, all the high peaks in Oxford county may be said to be granite. Wherever there is any slate or schist it almost always occupies the flanks of the hills or the valleys. At the junction of the Androscoggin and Megalloway rivers, just over the New Hampshire line, no rocks are seen, but all the hills and mountains adjacent are granite. The borders of Umbagog Lake are mostly low, and the granite rocks underlying are best seen in the mountains back from the water. We need not specify further the localities of granite in Oxford county, as it is found in every town, and the future map will give in colors its exact limits.

Granite is probably abundant among the mountains of Franklin county. Saddleback is composed of granite, near Phillips; and probably Mount Bigelow, in the north-east border of the county. Granite is also found in Farmington, Chesterville, and other places in the vicinity. Dr. Holmes has given the details of its distribution there in the columns of the *Maine Farmer*, during the past year.

Granite of the Kennebec Region.

Ledge island, in the south part of Moosehead Lake, is composed of granite, as is also the shore east of the island, the latter being traversed by veins of quartz. The amount of granite about the lake is small. Granite is found on the eastern shore of Brassua Lake, an expansion of Moose river. Granite is said to be common in the south part of Somerset county, more however in the form of occasional patches, than in a great mass. In Norridgewock, upon Dodlin Hill, a quarry has been worked in the granite for many years. They have also been worked somewhat in Skowhegan, Hartland, and at Mount Tom, in Smithfield. It is also found in the wild lands upon the Canada road, though in small amount.

Granite is abundant in Kennebec county; but it occurs in patches, which may be beds in schist, overlying masses, or great veins. There is no great granite region here as in Oxford county. Sometimes the quarrying of granite from one of these patches has removed the whole of it, as in one case upon the Kennebec river, where the mass was of an oval shape, like a great nodule. There seems to have been an opening in the rock of this shape, which was filled up by a molten stream from beneath. An eruptive mass of granite appears upon Mr. D. Baldwin's land in Mount Vernon, where a quarry has been worked. The mass is ninety feet wide, in a hill, from both sides of which mica schist dips in opposite directions, to the north-west and south-east. The length of the granite is unknown. A few crystals of pyrites are found in the south-east side of the granite. In the east part of Wayne there is a granite of peculiar appearance, from which boulders have been torn and deposited in a southerly line from the ledge by the drift current. From the eastern line of Winthrop, to the hill back of the State House, in Augusta, granite may be seen at every exposure of the ledges. The granite in Augusta is like that at Hallowell, of very good texture and rift. It is more or less tabular. Some portions of this granite are very tough, in consequence of being hornblendic.

The granite of Hallowell has long been noted for a building stone. It is composed of white feldspar, silvery gray mica, and but little quartz, the feldspar predominating. It is as white as the whitest granite, appearing at a distance, when smoothed, almost like white marble. The crystals of mica are generally arranged with their axes in the same plane, so that the rock splits very easily in the direction of these axes. There are several quarries, of which some have been abandoned in consequence of the exhaustion of the best qualities of the stone. Blocks of granite have been split out which weigh more than a hundred tons, containing 1,200 cubic feet. It is said that in one of the Hallowell quarries there are twenty-six different sheets of granite that can be worked, and that these sheets are arranged like strata. These sheets vary from eight inches to four feet in thickness. The poorer qualities of the stone contain pyrites in small quantity. Dr. Jackson says that the granite at the Hallowell quarries shows many long fissures or cracks, all with the same direction of north 70 degrees east. He thinks that they were produced by an earthquake at some unknown period. There is a curious specimen of the Hallowell granite at the State House. It is of the shape of a flattened cylinder, about 18 inches wide and 6 inches thick. It is nearly two feet in length, but it is now impossible to ascertain how long the cylinder was originally of which the specimen is a fragment. Were the specimen obtained from a sandstone formation, it would be exceedingly like the trunk of a tree, somewhat flattened by pressure.

Granite is found also in Belgrade, Gardiner, Bowdoinham and Turner. Upon the side of a mountain in Turner the granite is in immense blocks piled upon one another, so that there are large cavities between the fragments, which have been honored with the name of caverns. Probably frost and gravity, and possibly early denudation have caused the falling down of these masses and their present arrangement. Granite rocks are traversed by natural joints and the separation of the jointed masses would be effected very easily primarily by the freezing of the water filling up the cracks. The force of the expansion of water in freezing is nearly as great as that of the explosion of gunpowder, and hence rocks may often be rent asunder as easily by the freezing of water as by blasting.

Granite appears in ledges in the south part of Dresden. There is granite on Squam Island, which has been quarried, in which there is considerable pyrites. In Edgecomb, the granite has a bluish tint. It is the tabular variety, the tables dipping 85 degrees north-westerly. Much black mica is present. Bath also, has its granite. Some masses of it in West Bath are of very great extent. There is a long vein of granite in the mica schist of Phipsburg. In Bristol, Bremen, Newcastle and Nobleborough, there is granite similarly situated with that in Edgecomb and Bath.

Granite along the Sea-coast.

It is only along a part of the immediate sea-coast that granite ledges are found, and that is chiefly between the mouth of the Kennebec river and Jonesport. Cape Newagen, in Southport, is composed of gneiss containing veins of granite of a light color. The same rocks are found at Boothbay. At the end of Pemaquid Point, in Bristol, there is a large vein of granite, varying in length from twelve to thirty feet, which has produced much disturbance in the adjacent mica schist. The granite has overturned several of the strata of the schists so that they dip to the north-west. For three miles on the east side of the Point there are numerous large veins and beds of granite in connection with mica schist, generally from three to ten feet wide. It is a coarse, white granite, mostly composed of large crystals of white feldspar, with only a small amount of gray mica and quartz. Manhegan Island is composed of granite. So is Pleasant Point, below Friendship, and the small islands adjacent. Upon Herring Cove Island and Franklin Island, the granite occurs only in veins. They are all run about north and south. Granite is found in the following other places west of Penobscot bay: the whole of St. George, Rackliff's Island, White Head Island, Seal Harbor, Friendship, Long Island and the Two Brother's Islands. Upon White Head Island the granite has been cut through by an immense dike of trap, fifty feet wide, and traced north-easterly until it passes under the ocean. Lateral dikes proceed from the principal one. The trap contains large fragments of the granite imbedded in it, which shows conclusively that the trap was injected into a crevice in the granite. The granite in Friendship is of a light color and contains small blood red garnets in great abundance. In Waldoborough there are several quarries in the granite, all of them less than a mile northerly from the village. One of them is an immense vein, dipping 20 degrees north-west. The granite in another quarry is a fine grained light colored rock, composed of small crystals of feldspar and quartz, with only specks of black mica. There is much granite in Warren, in the south part of the town; particularly on a hill west of South pond. Near a school house in the vicinity there are beds of coarse granite in mica schist. In the south-east part of the town there is a large amount of beautiful porphyritic granite, which extends southerly into Cushing and Friendship.

Mount Waldo, in the south part of Frankfort, 264 feet high, is a very pretty mountain of granite. It is dome shaped. The granite is of the porphyritic variety, the feldspar being in large crystals, generally about half an inch wide. It is remarkably free from pyritiferous impurities. Musquito Mountain, 527 feet above the ocean, is precisely similar in its geological structure to Mt. Waldo. These two mountains, with Treat's Mountain, which is probably composed of the same granite, are closely packed together, and form an interesting feature in the scenery of Penobscot river. They seem to be the western terminus of the enormous granite development of the south-eastern portions of the State. There is a small amount of a very beautiful granite in Northport, near the Witherby house.

Granite in the South-eastern Counties.

The amount of granite in Hancock and Washington counties is very great. There is first the immense curve of granite mountains already noticed, from Bluehill to Mount Desert Island; then it is continued along the sea-coast to Jonesport; from Calais westward there extends a granite range upwards of twenty miles in width, into the wild lands; there is probably also another range in the wild lands farther north, besides the granite range appearing in Topsfield. The granite here forms immense mountains, often several thousand feet high, but their exact heights have never been ascertained, if in fact they have ever been scaled by human feet.

The granite at Buck's harbor in Brooksville, near Castine, is the first locality of this rock east of the Penobscot. The rock is rather coarse grained, but is free from impurities, and makes a handsome stone when dressed. The feldspar is white, composing the greater part of the stone. It is mostly situated upon a hill back of the harbor. The granite at the south end of Bluehill Neck overlies strata of gneiss and mica schist. That upon Long Island, in Bluehill bay is similarly situated, forming about one-half of the Island. There are many veins of quartz in the granite, containing copper pyrites and arsenical iron. Other minerals occurring in veins here are fluor spar, galena or lead ore, phosphate of lime or apatite, and sulphuret of molybdenum. The feldspar of the rather coarse granite has a reddish brown color. At Long's cove, in Bluehill, the granite is of a light color, the materials being mostly crystalline masses of feldspar. Some parts of it are very fine grained. The quarries here are quite extensive. Granite is found upon some of the islands in Penobscot bay, though in small amount; as in Vinalhaven, Deer Isle and Isle au Haute. The greater part of Sedgwick is underlaid by granite.

We suppose that the granite continues from these localities north-easterly through Surry and Penobscot to Orland, where we crossed it. Leaving Bucksport for Ellsworth, we first saw an immense number of granite boulders east of the village of Orland, and presently the ledges appeared, south of Alamoosook Pond.

The granite is a beautiful porphyritic variety, with black mica, decomposing rather readily. Occasionally we saw beautifully colored varieties. The granite continues to the great plain in the west part of Ellsworth. Topographically it forms a high range of mountains, and the belt is twelve miles wide. From the general topographical features of the country north we conclude that this range form a great curve, perhaps in the towns of Dedham, Otis, Clifton, Maria, No. 21 and Eastbrook, before reaching to Franklin, where we again crossed it. The probability is that the greater part of Hancock county north of Ellsworth is underlaid by granite.

Nearly the whole of Mt. Desert Island is composed of granite, or syenite. There is a little mica schist, however, in the small island west, near the Trenton Toll-gate. In passing from the Toll-gate to South-west Harbor, the following varieties of rocks are seen. West of the Toll-house is a beautiful syenite, which might make a magnificent building stone were it not too hard. A company once attempted to work it, attracted by its color and texture. At the Toll-house itself there is a ledge of mica schist, also at a mile east; all dipping south-westerly. Between these ledges there are three large dikes of trap. Passing over these two small islands, we come to the main island, to the town of Eden, and find granite for the first mile of our course. Then mica schist appears again, in a belt less than a mile in width. Near the south part of Eden we cross a development of beautiful red granite, largely composed of small crystalline fragments of red feldspar. The granite presently changes to the common white variety, in which we noticed no change nearly to the South-west Harbor, with the exception of some large dikes of trap. The road crosses a range of granite mountains, the same which make the scenery of the island so famous. These grand summits are the only interesting features of interest upon the island, for the presence of the ocean so near these naked masses of granite in the recent geological periods has swept away most of the soil, leaving the island very barren. The view from the summits of the high peaks must be admirable. Adjoining South-west Harbor the granite is very fine grained, and appears to have passed into quartz rock at two localities among the settlements. At the sea wall, and beyond the farthest house, we examined in a compact granite, mostly composed of feldspar veins, containing beautiful green feldspar. The salt water at high tides covers the feldspar, and has removed the green color from the most exposed crystals. Petit Menan and Baker's Island, near Mount Desert, are granitic.

From Sullivan to Jonesport the rocks along the coast are mostly either granite or syenite. The Sullivan granite is famous as a building stone. The granite passes from Sullivan and Steuben northward, also, occupying the whole of townships 7, 9, 10, 16, 22, Beddington, and large portions of Franklin and Cherryfield. The western edge of the granite in Franklin, (at the Baptist church,) is composed of syenite. All the rest of the rock, for twenty miles in a line crossing the range at right angles, is the common white granite. As before, the granite range forms large mountains, as Young Tunk Mountain in Cherryfield, Bald and Tunk Mountains in No. 10, besides numerous other lofty peaks without a name or locality, even, on the map. We have traced this range as far as Deveraux. How much further it extends is unknown. It may be connected with the granite running westerly from Calais and Robbinston.

Passing over to Marshfield we find another range of granite, which is connected with the one just referred to. We have examined it in the townships of Marshfield, Nos. 14, 18, 19, Cooper, Meddybemps, Charlotte, Robbinston, Calais and Baring. We have also examined its prolongation into New Brunswick, where it is of immense length, as it passes from Calais to the St. John river, and thence north-easterly mostly through the Province. If we consider the granite in New Brunswick and in Maine east of Penobscot river as belonging to the same range, but with several branches, we have an example of the greatest development of granite in any region east of the Hudson and St. Lawrence rivers, if not the Mississippi.

There is nothing of special interest in the details of these granites. We find another mass of granite in Topsfield extending easterly and westerly to an unknown distance. The large mountains west of Topsfield appear to be granitic, and we have examined the eastern development of this range on the east side of Schoodic Lake, in New Brunswick. It may be connected with the granite in Lincoln, Enfield and Greenfield, where the rock is largely developed. This granite is both dark and light colored, occasionally contains hornblende and large blotches of feldspar.

Granite in Northern Maine.

Most of the granite in Maine is found in its western and south-eastern counties, yet is by no means wanting in the more northern portions. The region of Mt. Katahdin shows an immense development of it, from the unexplored region east of Moosehead Lake to the East Branch of the Penobscot. The Katahdin mountains rising suddenly out of a rolling country to a great height, illustrate the topographical mode of the development of this rock very finely.

There appears to be a range of granite and syenite from Island Falls, No. 4, R. 4, on the Mattawamkeag river to Linneus and New Limerick. Boulders of granite are exceedingly numerous at the north end of Churchill Lake, and the ledges cannot be far distant. The general absence of granitic boulders in Northern Maine shows, as well as the nature of the rocks in place, the great difference in the geological and agricultural character of the two districts. The absence of granite is generally partial evidence in favor of a good soil; which evidence is strengthened by other considerations in the case before us.

Graphic Granite and Eurite. Graphic granite occurs in Paris, on Bradbury mountain in Pownal, Topsham and Brunswick. Eurite has been found only in a boulder near John Carney's in Moscow. It is not as handsome as some splendid specimens from North Carolina, but we call attention to it in hope that its parent ledge may be found and an investigation be made into the origin of its peculiar mottled structure. The best specimens are snow white, thickly penetrated by black cylindrical stems about the size of our common lead pencils.

SYENITE.

Popularly syenite is not distinguished from granite. It differs from it only by the substitution of the mineral hornblende for mica. Both the minerals are commonly black, so that the general effect of the two rocks is the same. The same varieties that were mentioned under granite may be applied to syenite. Often the same rock contains both mica and hornblende, when it may be called *syenitic granite*, or *hornblendic granite*. Syenite is apt to be harder than granite, and more readily passes into greenstone. The name syenite is derived from Syene in Egypt, where a famous red granite quarry, known from the earliest times, is located. The rock at Syene is not Syenite, however. The name though improper has become fixed. A proposal was made to change the name to *Sinaite*, because Mount Sinai in Arabia is composed of genuine syenite; but the suggestion has never been adopted.

The most prominent localities of syenite in Maine are along the shores of the south-eastern counties, and in York county. Beginning at its most eastern locality, we find it north of Calais, on the Baring road. It is a coarse aggregate of hornblende and feldspar, the quartz being very scarce in it. Passing southerly into Robbinston there is a curious variety of red syenite, at a distance resembling certain varieties of red sandstone, by whose side it is found. It extends along the shore from Devil's Head to Liberty Point, and south-westerly in its lateral expansion to Jonesborough, and perhaps to Mt. Desert. Neutral Island in the St. Croix river is the same rock, and some parts of St. Andrews, N. B. This rock is very tough. Liberty Point is occupied by an interesting breccia; the fragments consisting of large pieces of red porphyry and trap, sometimes two feet square. Small veins of graphite are found in this belt of syenite in Charlotte and Marshfield, very near the Devonian sandstones; so much so that we tried to persuade ourselves that the former was a higher member of the sandstone, perhaps of the coal formation; and that the plumbago was the only relic left of former coal plants.

Probably all the rocks in southern Jonesborough and in the promontory of Jonesport are syenite. There is another coarse syenitic breccia in Jonesport, whose fragments consist of trap and amygdaloid. Dikes of trap are frequently found in the syenite, and are the most recent of the two; as the basis rock must always be older than the intruding mass. The syenite continues westward to Pleasant river. We also found syenite in abundance at Milbridge, and several of the islands in Narraguagus bay. There is much syenite upon Mt. Desert Island, but it has been difficult to assign it to any marked district separate from the granite. It is particularly abundant at the North-east Harbor. It there contains veins of magnetic iron, arsenical iron, and pyrites. In Franklin there is a narrow belt of syenite on the west side of the granite. Thus both the east and west sides of the granite are bordered by syenite.

In Raymond and Wayne syenite has been found. In Wells, half a mile west of the village, there is a hill of syenite 70 feet high. The rock is a bluish green feldspar, with hornblende in black crystals, and a little quartz. The three mountains in York called

Agamenticus, of which the highest is 672 feet above the ocean, are composed of syenite. Its feldspar is of a brownish green color. The rock at Cape Neddick is syenite. Some mountains in Newfield, 1,600 feet high, are also composed of syenite.

There are three localities of syenite in the northern part of the State. One is in connection with the granite at Island Falls, No. 4, R. 4, of Aroostook. It is a bluff of syenite 300 feet high at the end of a ridge three-fourths of a mile long. A beautiful boulder of syenite found in No. 3, R. 5, awakens the hope that so fine a rock may be found in place near by. Three miles west of the Aroostook river, above the Oxbow, in No. 6 or 8, there is a development of this rock.

Granite, syenite, protogine and eurite are generally represented by the same color upon geological maps. Geologists have not been careful to distinguish them, because the importance of doing so has but recently been felt by them. The origin of all is supposed to be the same, whatever that may be.

Protogine. This rock, called also talcose granite, is a mixture of quartz, feldspar and talc, or the talc of talcose schist. Having been confounded with granite it is not so well known as its importance deserves. It has been generally supposed to belong to the Laurentian system, but we have found it of Devonian age in immense amount in Vermont, and of more recent age still in Rhode Island. We have seen it in great abundance in Maine, but cannot at this moment recall any locality except two small dikes in Winslow, at the east end of the Penobscot Railroad Bridge. The largest is only ten feet wide. Their course is northeasterly, not far from the direction of the strata.

Origin of the Granitic Rocks.

We have already intimated our theory of the origin of granite, but wish here to state the reasons for our theory more fully.

The prevailing (and we think erroneous) opinion is that all granite was once melted volcanic matter, thrust into every crack in the overlying strata, or poured out upon the surface from large vents, and cooled and crystalized under great pressure and with extreme slowness. It is found also, that other rocks adjacent to the granite have suffered mechanical displacement. It has been supposed that granite formed the axes of all our mountain ranges, the strata dipping away from them on the opposite sides.

Our theory supposes an agneo-igneous fusion, or the combination of a moderate heat with water or steam, ·rendering the original materials so plastic that the primal structure of the rock was wholly obliterated, and that then new crystalline masses were formed out of the fused mass. The original materials are as really fused by the one as by the other theory; only the heat required is much less in the latter case. Granite may have been formed out of schists, and originally from shales and sandstones. It is only an example of metamorphism, as explained upon a previous page, carried to its utmost limit; carried far enough to obliterate all traces of stratification, foliation and lamination.

Observation shows that granite does not always constitute the axes of mountains, but that it often lies between strata, and instead of having been the agent by which they have been lifted up, it has only partaken of the general movement which has resulted from a general cause. We have seen from the description of the granite rocks of Maine that they as often form beds in and lie beneath strata as they compose the backbone of hills.

The dry heat required to keep granite melted must be intense. It cannot be heated in the most powerful blast furnace, and where the melted matter was in close contact with colder walls of rock into which it was supposed to be injected, it must cool so quickly that it could not have time first to penetrate all the narrow crevices in which it is now found in the form of veins. Again, if it crystalized from such fusion, the quartz would have been consolidated and crystalized first because less fusible than mica and feldspar; but it was the last of the ingredients consolidated. If one examines a piece of granite he will see that the crystals of mica and feldspar are often perfect, but the quartz never. It is in the amorphous state; *i. e.* is not crystalized. To make room for themselves the crystals of mica and feldspar have cut into the quartz apparently. This is beautifully seen in graphic granite. There is no way to account for this fact, except to say that the mica and feldspar were formed previously to the production of the quartz, and that admission prohibits the adoption of the view that the crystals cooled from a fusion by dry heat. Granite, also, contains imbedded with its own ingredients not a few hydrated minerals; or such as contain water in their composition, and must therefore have been produced in the wet way.

We have supposed that sedimentary rocks have been brought into a plastic state by the joint action of heat and water; and why may not the same agencies somewhat intensified, or acting for a longer time have made the crystalline stratified rocks still more plastic and at length unstratified? If water be admitted as the principal agent, heated by the caloric escaping from the earth's interior, and prevented from escaping by thousands of feet of superincumbent rock, complete plasticity would result at a temperature far below that required to melt granite in a dry state. We must suppose that all these metamorphic processes have been carried on far below the surface, perhaps beneath strata, and perchance at the bottom of a heated ocean.

By this view a large proportion of granite rocks may be only metamorphosed schists. If so, it explains why they have disturbed or changed the adjacent strata so little—the chemical influence rarely being traceable more than a quarter or half of a mile. In some instances, they may have been thrown up from the melted interior of the earth, and possibly in a state of fusion, without water. If only five or ten per cent. of water be present, it is calculated that the heat need not be as high as redness to produce the requisite plasticity.

If it be doubted whether water penetrates so deep into the earth's crust as we know granite to extend, it should be recollected that the stratified rocks, all of which were originally deposited from water, and so far as we can judge, retain more or less of it still, are from ten to twenty miles thick. But if even lava owes its fluidity in a measure to water, it may be supposed to be present in liquid granite with equal reason. In short, whoever admits the aqueo-igneous origin of the crystalline foliated rocks, will feel compelled to admit the granitic rocks to have resulted from essentially the same causes. Nor is the theory very different, after all, from that which has usually prevailed. It admits fluidity from heat in the materials, and only introduces water as an important auxiliary in the work.

TRAPPEAN ROCKS.

The mineralogical character of the Trappean Rocks in Maine has not been studied sufficiently to enable us to give the names of all the comparatively unimportant varieties of them which occur in the State. Their general character is that of a dark colored, fine grained, homogeneous, exceedingly tough rock, occurring mostly in veins or dikes. Often very heavy and occurring in narrow irregular belts, they have occasioned a view apt to be commonly entertained that they are iron ores. The trap or greenstone rocks proper consist of feldspar and hornblende or augite. The external appearance of trap and basalt is the same, and for our present purposes it is not necessary to distinguish them. After describing the trap rocks, we will speak of amygdaloid and porphyry.

The trap rocks of Maine occur as dikes, as overlying masses, and as beds. A dike is the melted mass of matter filling up great chasms in the older rocks which has subsequently cooled. The melted matter seems to have exuded from these fissures and sometimes flowed over at the surface so as to spread out and overlie the adjacent rocks to a greater or less extent. Perhaps the bedded traps are only examples of overlying masses, which have rested conformably upon strata, and were subsequently covered up by other strata deposited upon them. Often this variety is composed of a coarse conglomerate of trap pebbles, and is almost a sedimentary rock.

Trap Rocks in Washington County.

In no part of the State are these rocks so well developed as in Washington county. They form a part of a great trap region which also covers a large part of the south-western portion of New Brunswick. The great outflow of trap in this region has greatly altered the character of the sedimentary strata, producing the metamorphic belt of jaspers and siliceous slates described above.

North-west of the narrow syenite belt from Jonesport to Robbinston, no trap rocks have been observed except a few dikes in Princeton. Between Robbinston and the Indian village in Perry, there are numerous dikes of trap which have acted distinctly upon the enclosing sandstones, changing them to trap-tuff and scoriæ. In the tuff are found nodules of calcite and geodes of agate, containing amethyst, apophyllite and analcime, hydrated minerals crystallized when the rock was soft, hot and plastic. Moose Island; upon which Eastport is situated, is almost wholly composed of trap rocks of irregular form, showing a slight tendency to assume the columnar structure. It is frequently filled with nodular minerals. There is a little flinty slate on the northern portion of the island, which must have been hardened by the trap. There are a few impressions of marine shells in it. A few insignificant veins contain galena and copper pyrites, showing the metalliferous character of the rock, and illustrating the fact that small metallic veins are always found in the vicinity of large veins, such as are worked in Lubec. In the north part of the island the trap rocks are made up of thin tabular sheets, resembling strata. Crossing over the bridge to Perry, we first see a red conglomerate; but very soon notice a trappean rock appearing much like a bed, or a stratified formation. We can trace it around Pigeon Hill, then along the road to the post-office in Perry, thence north-westerly to the west side of Boyden Lake in Charlotte. It underlies the Devonian sandstones, but overlies the Upper Silurian strata of Perry. In the south part of Perry it is very narrow, but is two and a half miles wide in the north parts of Perry and Pembroke. A section of the rocks in Perry having this bedded trap is given in figure 7.

The sandstone near the junction often has a cement of vesicular trap. On the west shore of the lake the line is not well marked between the trap and indurated sandstones. These traps appear to be overlying masses. We think that the other trap rocks in the vicinity to be dikes altogether. We cannot speak from personal observation concerning the coast between West Quoddy Head in Lubec and Cutler, but think all the traps away from the coast are dikes. The prevailing formation in Lubec is Upper Silurian. But the dikes are so numerous as to lead one at first to suppose trap to be the prevailing rock.

Perhaps the description of the order of rocks between West Quoddy Head, the most eastern point of land in the United States, and the extremity of Gove's Point in Lubec, will give a good idea of the number of dikes in this region. Many of them seem to have a north-easterly course, which does not generally accord with the direction of the strata. At the Light-house the rock is trap—a dike. Passing along the shore northerly we find clay slate in which are small beds of trap. The first mentioned dike has elevated the strata of slate—changing the dip in twenty rods from twenty degrees to perpendicular. Close by the first dike, in rounding the point, we come to an immense dike, which runs through the head, constituting its greater portion, and perhaps uniting with the first one. The trap assumes somewhat of the columnar structure in the second dike. Following around the head still further on the north side, we find the slate again, occupying the whole of the low land to the higher land west of the Carrying-place, except a small dike east of the immense peat-bog. On the bank west of the Carrying-place is a dike of crystalline trap. Between this point and the junction of the road from Quoddy Head with the road from West Lubec to Lubec there are four more dikes in the slate. The rocks at Lubec village are trap, enclosing three narrow ranges of slate. Taking the road to Gove's Point, to continue the section, we find that most of the rock between the West Lubec road and the church about two miles north of Lubec Mills, is trap. Two miles before arriving at Gove's Point on the western side of the promontory, there are high precipices of porphyry. At the end of the Point we find the common trap, red porphyry and a brecciated trap. The stratified rocks upon this promontory are Upper Silurian limestone, and a sandstone, probably of Devonian age. Trap rocks are numerous about the Lead Mines. The veins of ore are in trap. The number of the dikes is very great, but we cannot say how many.

In our visit at the mines, every attention was shown us by the gentlemanly manager of the mines, whose name has escaped us. He has made a geological section of this region of country, which displays a practical acquaintance with the science of geology. He thinks that the igneous rocks of Lubec and vicinity were injected at five different periods, and his reasons are certainly convincing. It is a very fine region to study geology, as within a short distance can be found igneous rocks of five different ages, and two fossiliferous formations, besides a clay slate, which is probably fossiliferous also. We can distinguish readily four ages of igneous rocks here. The oldest is a porphyry. This has been displaced by a trap rock, which is the metalliferous series, we believe. Since the trap has displaced the porphyry, the trap must be the newest. A third set of dikes are of a brecciated trap, containing fragments of Nos. 1 and 2 in its grasp. Now these three sets of dikes were all injected earlier than the later part of the Devonian period, because in a Devonian conglomerate close at hand we find fragments of these igneous rocks. The dikes must all have become cold before any of their fragments could be broken off and deposited in the Devonian period. The fourth dike is a varigated trap, cutting the Devonian conglomerate. The fact that it cuts across the rock containing as its constituents, portions of Nos. 1, 2, and 3, proves it to rank at least number four on the scale. We regret not to be able to give the courses of these different sets of dikes, and also more facts concerning them. Our mind was full of them when we examined the localities; but having neglected to note them down, they have escaped our recollection.

The rocks in the west part of Dennysville are trap. Dikes of trap may be found upon Roger's Island, at Comstock's Point in Lubec, north of the lead mines in Lubec, Leighton's Point on Denbo Neck, at Davis' Point in Lubec, at Nutter's Cove in Perry, and in Pembroke. It is the most prominent rock in this vicinity, as the sandstones and slates, when occurring, are much less conspicuous. Denudation has carried away very little of the trap, therefore this rock forms all the headlands and precipices. The whole of Campo Bello island and Deer island, both in New Brunswick, are composed of trap.

Several causes conspire to make the scenery about these trap precipices unusually interesting; for example, at West Quoddy Head. The precipice is over 100 feet in height, a light-house is built upon it, and the tide beats loudly upon the shore, rising and falling more than thirty feet every day. There is a wildness about the spot which is greatly increased by the fogs so frequently settling down over the ocean adjacent to the shore, when the ringing of the fog bell, echoing from crag to crag, gives the sailors warning of their danger. In clear weather, the singular outline of Grand Manan looms up in grandeur, above the sparkling ocean.

In following the Atlantic coast westerly from Lubec, most of the rocks are trappean for a great distance. The original clay slates are altered into cherty and flinty slates, which do not differ greatly in topographical features from the greenstones. These altered rocks may be seen at Lawrence's cove, Broad cove, Haycock's harbor, and the mouth of Little river. Trap rocks form the headlands of Little Machias bay. A large dike of beautiful white quartz is found on the north side of the opening. Cross island is entirely composed of trap, probably an overlying mass, which on the south side is precipitous, 166 feet above the ocean. Veins of calcite and chlorite are found upon the island. The chlorite is a very soft bright green stone, and was used formerly by the Indians in the manufacture of their pipes. It can be obtained in masses a foot square. Bears' island, Buck's harbor island, and Libbey's island, are composed of trap rocks. Parts of Lakeman's island at the mouth of the Little Kennebec river, and Roque island are trappean, the rest being red sandstone, either metamorphic or unaltered. Probably many other islands off the coast of Washington county are composed of trap, but they have not been examined, save Flint island in Narraguagus bay. The rock is flinty, and is intersected by numerous dikes of trap. We counted twenty-seven of both trap and porphyry upon the south side of the island, and there are double the number upon the whole island. It is one of the most interesting localities we have seen in Maine for the study of the phenomena of dikes. They are more numerous than upon the west shore of Machiasport, which have already been described under metamorphic slates.

Geology of Grand Manan.

The predominant rock upon this island is trap, which forms very high precipices upon its western side, constituting the grandest scenery that can be found off the coast of Maine or the United States. The island was visited by Mr. Houghton, who made the following notes respecting it: "The west part of the island is high, and meets the ocean with cliffs of trappean rocks from 100 to 300 feet high. In some places, these cliffs extend a considerable distance beneath the water, but are generally skirted by sea beaches. One beach, near the north end of the island, is frequented in summer by the Passamaquoddy Indians, for the purpose of capturing porpoises. The beaches in the south-west part of the island furnish a great quantity of pebbles for paving. Three schooners were being loaded with them when I was there. The eastern part of the island is inclined towards the water; and in the north part the cliffs present a fine exhibition of red sandstone. The central part of the island, from Swallow Tail Point to Woodworth's or Fisher's Cove, presents a low shore with no rock in sight.

"Just off Woodworth's Cove, there is a ledge of reddish purple quartz, a rock of rather homely appearance. Duck Island is composed of talcose schist, dipping from sixty to seventy degrees easterly, with the strike of north 10 degrees west. The islands to the south-east, (Ross, Cheney, and White Head,) are composed of mica schist and gneiss. They told me of limestone on White Head, but I found none, though I did not visit its extreme end.

"The south-east part of Grand Manan presents a gentle slope to the sea, and is admirably adapted for farming. On Inner Wood Island, I found red conglomerate with fine red sandstone, dipping sixty degrees easterly, with the same strike as before. Great quantities of sea gull's eggs are gathered on this island. The birds are protected by the inhabitants, who mulct to the amount of five dollars for every offence the unfortunate sportsman who makes game of them. The south-west part of Grand Manan is truly a magnificent sight. The cliffs are higher than in any other part of the island, and the scene is made picturesque by the immense flocks of sea birds sitting pensively upon the craggy summits, or wheeling in circles around the tops of the cliffs. I know of no spot more interesting to the lover of the wild and picturesque in nature."

Trappean Rocks in the southern part of Maine.

The trappean rocks in the southern portions of the State, occur uniformly as dikes or veins. They are frequent, but generally uninteresting. They are numerous along the sea coast of Hancock county. At North East Harbor, on Mount Desert, the trap dikes appear in the granite of great size. They run north-easterly, are nearly perpendicular, and from five to fifty feet wide. On Marshall's Island there is a large dike, from which branches a vein of magnetic iron ore. Immense dikes appear in various parts of Vinalhaven. Upon Little Deer Island, the trap is mixed with serpentine. It seems to be a central mass from which several small dikes radiate. The whole mass being insulated forms a conical peak, and very much resembles the crater of a volcano.

The most energetic displays of trap rocks are found upon the east side of the Penobscot river. Passing westwardly, we do not find them so abundant, yet they seem to have been injected at the same time, as the directions and lithological characters essentially agree. The dikes at the limestone quarries of Rockland and Thomaston are the most interesting, because the numerous excavations there made have exposed them to view so beautifully. A dike may be traced through several quarries, in all of which it may be seen ploughing its way, as it were, to a great depth. As the stone is of no value, it is left in its place, and sometimes forms a wall running through the middle of a quarry, or crossing it from one side to the other. The dikes occupy former fissures in the strata, and therefore follow their directions. Sometimes they are strait, and again are curved. A curious form of a dike was noticed in the Meadows' quarries. Instead of one long mass of trap, these were a series of large nodular masses of trap, like so many pockets, arranged in a row. Sometimes a narrow thread would connect the masses together, but generally there was no apparent connection between them. The largest nodules were several feet in diameter. The following directions of the dikes were noticed in these quarries: east and west, north north-east, and south south-west; south-east by east. None were over ten feet wide.

Trap dikes were noticed in the following localities: in Hampden, on the west side of Penobscot river; in Hancock and Ellsworth; on Bluehill neck, where they are interstratified with gneiss; several beds of the same character on Long Island; in great number in Brooksville; several in the syenite at Owl's Head in Rockland; in Hope, at the limestone quarries; on White Head Island; in Windham; in Standish; in great abundance in Kennebunk; several on Kittery Point; one thirty feet wide on Thyng's Mountain in Newfield; several at Fogg's Mills in Limerick, the widest of which is 30 feet; in immense amount at Great Falls village in Gorham, and in many other places.

The trap dikes in the vicinity of Portland form one of the most interesting features in its geology. For the most part, their direction corresponds with that of the strata, and they can be traced to a great distance. They have more or less of the columnar structure; the columns always lying across the dike, or horizonzal. Could the strata be removed, leaving the trap, it would be a stone wall, made up of small columns arranged like a pile of wood. An example may be seen on Jewell's Island. When the trap rock of the coast easily decomposes, the water of the ocean removes its material, leaving a narrow chasm; as at the Portland Light-House on Cape Elizabeth, about three miles from Portland.

We may be able to trace a trap dike from Richmond's Island to Jewell's Island, a distance of twelve and a half miles. The directions at these two localities correspond, and at the Light-House on Dyer's Point, intermediate between the islands, the same dike appears, and by looking at the two islands, the connection appears very probable. It is said that upon another island some eight or ten miles north-east from Jewell's Island, a dike appears; it may be the same one, as its direction is north-easterly. Dikes may shift a few feet, as this one has done in several places on Jewell's Island, without altering their general direction.

North-west from Portland there are frequent examples of trap dikes, each from one to five feet wide. The granitic rock which contains them, is so divided by the ramifications of the trap, that one can hardly say whether the rock is veins of trap in granite, or granite veins in massive trap; and so firmly are the two kinds of rock united that they separate with little less facility at their junction, than they divide anywhere else. Good examples of these veins occur a mile north of Pride's bridge, over Presumpscot river in Westbrook.

Much of the trap about Portland appears to be in the form of beds. This may be seen not only where the strata are perpendicular, but also west of the city, where the strata incline at a comparatively small angle. This fact is useful to us when reasoning upon the origin of trap.

In York, at Bald Head, there are three sets of dikes intersecting one another, consequently we are able to judge of their relative ages; for the oldest dike will be the one that is cut through by the rest, while the most recent will not be traversed by any other one. Accordingly the dikes in York are of three different ages. The eldest is a porphyritic trap, developed in very large dikes in the slate, and running north 55 degrees east. The second series of dikes cut across the porphyritic dikes, and have frequently greatly displaced them. These run north-easterly, and are the most common of all the dikes in southern Maine. The third series are brown scoriaceous trap, cutting across the common trap. As some general cause has produced fractures over a large area of essentially the same direction in the same geological period, it is probable that all dikes having the same direction are of the same age; as they were injected into these parallel fissures. The rents which were made in another period may have a different direction; and hence we may be able to distinguish the ages of trap dikes as well by their direction as their difference in mineral structure.

Trap in Northern Maine.

There is a considerable porphyritic trap near the foot of Chesuncook Lake, and upon Ripogenus Island. In New Limerick, at a quarry of limestone, there is a large dike of trap. East of Mount Katahdin, upon the east branch of the Penobscot, and upon the Seboois river, there are immense masses of trap, forming mountains and perhaps ranges. Lunksoos mountain on the Penobscot, and Peaked mountain on the Seboois, are examples. Sugar Loaf mountain on the Seboois, is cut through by a mass of trap 500 feet wide. On the Aroostook river, trap appears near Ashland and at the falls, where it joins the St. John river. Another mass of trap appears between the "Pond pitch" and the "Upper Falls" on the east branch of the Penobscot. It appears to correspond in its general character and position with the trap in Perry, which underlies the Devonian sandstone; for the rock at the Upper Falls overlying the bedded trap, is a coarse conglomerate of the same age as that in Perry.

Boulders of a fine amaygdaloidal trap are common all along the East Branch, the Seboois, and the Upper Aroostook rivers. They may have been derived from a trap region in the unexplored country between Ashland and the Seven Islands Farm. Rev. Mr. Keep informs us that a similar rock is common between Fort Kent and Ashland. Upon Chamberlain Lake and Heron Lake there is an immense development of an exceedingly coarse trappean conglomerate, so trappean in its general aspect that it is difficult to say whether it was an igneous or aqueous rock. The details will be given in the special report upon the Wild Lands.

Porphyritic Rocks.

The term porphyry is a general one to denote a particular form in which certain minerals are disposed in igneous rocks. The word means purple, or variegated, because the rock so denominated by the ancients was of this color. Igneous rocks with a homogeneous, compact, or earthy base, through which are disseminated crystalline masses of some other mineral of contemporaneous origin with the base, are denominated porphyry. The true classical porphyry has a base of compact feldspar with imbedded crystals of feldspar. The porphyry in Maine is mostly a trappean rock with imbedded crystals of feldspar. The feldspar is not simply crystalline fragments, but distinct crystals, displaying the crystalline form of the mineral in great perfection.

The porphyritic trap has frequently been alluded to in the description of the trappean rocks, particularly as forming the oldest series of dikes off the coast. Additional localities may be specified in Eastport; at Gove's Point in Lubec; Hog Island, where the porphyry is brecciated; at Buck's Harbor and Yellow Head Islands off Machiasport. The latter island consists of a yellow, compact feldspar or porphyry, forming a steep bluff, rising fifty feet above the ocean. Its wall exhibits an interesting section of the porphyry traversed by four dikes of trap. In York and its vicinity there are a great number of porphyritic dikes, which belong to the oldest series of dikes. In Brooksville, among the numerous dikes of trap exhibited, there is another of compact feldspar, cutting through the strata in an east north-east direction. It is a variety of porphyritic rock.

Besides the porphyritic trap on Chesuncook Lake, there is a most beautiful mass of this rock displayed north of Chamberlain Lake, about three miles above the union of Soper Brook with Eagle or Heron Lake.

Amygdaloidal Trap. This term, like porphyry, is general. Trap rocks are often filled with numerous cavities, very much like modern lava, and are then said to be *vesicular.* When these cavities are filled with quartz, chalcedony or zeolitic minerals, the rock is said to be *amygdaloidal,* from the Latin *amygdala,* an almond, because the zeolitic masses are frequently almond-shaped. Sometimes these cavities have been lengthened, so that the infiltrated minerals have a cylindrical shape.

We have already noticed several places where amygdaloid is found in Maine. Generally speaking, it is found in the south-east counties, and in the northern part of the State, particularly at the source of the peculiar reddish amygdaloidal boulders, so very common there. This rock is not as firm as trap generally, so that some have mistaken it for modern lava.

Catalogue of the Minerals of Maine.

At the close of our account of those rocks which contain most of the minerals of the State, we give a catalogue of all the minerals that have been ascribed to the State by all observers. They are arranged alphabetically, according to localities. When the names are italicized, it denotes that the minerals are found in great perfection, or at least that very fine specimens of them have been obtained from those towns. The list was prepared by Mr. Houghton, who, since his connection with the survey, has changed his residence to Bangor. He was largely indebted to Dr. Cleaveland's catalogue, and to Dr. Jackson's Reports, for much of the information embodied in the catalogue.

Mt. Abraham.—*Andalusite*, staurotide.

Albany.—*Beryl, green and black tourmaline, feldspar, rose-quartz.*

Albion.—Iron pyrites.

Andover.—Beryl.

East Andover.—Bog-iron ore, iron pyrites, native copperas.

Atkinson.—Bog-iron ore.

Augusta.—Pyrites, magnetite.

Arundel.—Pyrites.

Bangor.—Macle.

Bath.—Idocrase, graphite, magnetite.

Baldwin.—Emerald, pyrites, argillaceous oxyd of iron.

Belfast.—Molybdenite.

Bethel.—*Cinnamon-stone*, pargasite, sahlite, calcite, sphene, wad, beryl, tremolite, epidote, garnet, apatite, actinolite, egeran, graphite, talc, mica, tourmaline, hornblende, pyrites, mispickel, magnetite, fibrolite.

Bingham.—Massive pyrites, galena, blende, andalusite.

Bloomfield.—Pyrites, gypsum.

Bluehill Bay.—*Arsenical iron, molybdenite, galena, fluor-spar,* apatite, black tourmaline (Long cove,) black oxyd of manganese (Osgood's farm,) rhodonite, bog manganese, wolfram.

Bowdoinham.—*Beryl*, garnet, graphite, black tourmaline, ferruginous oxyde of tungsten, tremolite, molybdenite.

Brunswick.—Actynolite, *garnet*, epidote, *calcite, mica crystals* (*muscovite,*) *green mica, black tourmaline,* orthoclase, emerald, beryl, graphite, carbonate of copper, pyrites, sphene, molybdenite, *feldspar crystals*, staurotide, fibrolite, specular iron, chalchopyrite, nacrite,? apatite, compounds of tellurium (near Merrill's farm.)

Bristol.—Olivine.

Brooksville.—Pyrites.

Brownfield.—Magnetite.

Buckfield.—Magnetic pyrites, garnet, iron ore.

Bucksport.—Macle.

Camden.—Black tourmaline, epidote, talc, magnetite, pyrites, *galena, macle.*

Carmel.—Pyrites, macle, sulphuret of antimony, epidote.

Charlotte.—Graphite.

China.—Petalite.?

Clinton.—Pyrites.

Corinna.—Iron pyrites, arsenical pyrites.
Cross Island.—Chlorite, calcite.
Deer Isle.—*Serpentine, verd antique*, asbestus, diallage, magnetite.
Dexter.—Galena, pyrites, blende, copper pyrites, green talc.
Dixfield.—Native copperas, graphite.
Dover.—Bog-iron ore.
Letter E, Oxford Co.—*Native copperas, staurotide, macle.*
Eastport.—Chlorite, epidote, calcite, pyrites, galena, chalchopyrite, arsenical iron.
Eden.—Magnetite, arsenical iron, pyrites.
Exeter.—Galena.
Farmington.—Garnet (Morton's ledge,) *pyrites*, graphite, bog ore.
Fairfax.—Pyrites.
Falmouth.—Tourmaline.
Freeport.—*Rose quartz*, graphite, *mica.*
Fryeburg.—*Garnet*, emerald.
Gardiner.—Magnetite.
Georgetown.—(Parker's Island) *beryl*, tourmaline.
Gilead.—Alumina, muscovite crystals.
Gorham.—Garnet, staurotide.
Greenwood.—Quartz-crystals, graphite, *black tourmaline*, black manganese, beryl, black garnets, ilmenite, native arsenic.
Hallowell.—Black tourmaline, garnet, stilbite.
Hartwell.—Staurotide.
Harpswell.—Garnet, staurotide, pyrites, bog-iron ore, asbestus, steatite.
Hampden.—Graphite, pyrites, asbestus, serpentine.
Hebron.—Black tourmaline, staurotide.
Hodgdon.—Hematite, limonite, *pyrites*, bog-iron ore.
Hope.—Steatite.
Horset Island.—Oxide of molybdenum.
Jaquish.—Steatite.
Jewell's Island.—*Pyrites.*
Katahdin Iron Works.—Bog ore, sulphuret of iron, native copperas, magnetite, quartz crystals.
Mt. Katahdin.—Magnetite.
Kennebunk.—Sphene, pyrites, rose quartz.
Kingfield.—Pyrites.
Lennox.—Galena, pyromorphite.
Lewiston.—Garnet, graphite.

Limerick.—Black tourmaline.

Lincolnville.—Graphite, phosphorescent blende.

Lisbon.—Black tourmaline.

Linnæus.—Hematite, limonite, *pyrites, bog-iron ore.*

Litchfield.—*Cancrinite, sodalite, nepheline, zircon.*

Lubec.—Specular iron.

Lubec Lead Mines.—*Galena, copper pyrites, blende,* pyromorphite, an ore of Bismuth.

Machiasport.—*Jasper,* epidote, laumonite.

Madawaska Settlements.—Phosphate of iron in clay.

Madrid.—Gold.

Marshall's Island.—*Magnetite.*

Marshfield.—Graphite.

Marion.—Galena, graphite.

Minot.—Pyrites.

Moosehead Lake.—Magnetic black sand.

Newfield.—Bog-iron ore (Bond's Mt.,) mispickel, olive phosphate of iron in botryoidal masses.

New Limerick.—*Pyrites, bog-iron ore.*

New Sharon.—Gold.

No. 6, R. 8.—Calcite, chalybite, pyrolusite.

Norway.—Molybdenite, *chrysoberyl.*

Orr's Island.—*Steatite,* garnet, andalusite.

Paris.—*Tin ore, green, red, black and blue tourmaline, mica, lepidolite,* feldspar, *albite, quartz crystals,* rose quartz, pinite, blende.

Partridge Island.—(Passamaquoddy bay,) amethyst, jasper, natrolite, agates, chalcedony.

Portland.—Actynolite, garnet, epidote, amethyst.

Poland.—Idocrase.

Phipsburg.—*Yellow and manganesian garnets, idocrase, pargasite, axinite, laumonite,* ore of cerium, chabazite, cinnamon-stone, quartz crystals, augite, calcite.

Phillips.—Magnetite.

Prospect.—Jasper.

Petty-marsh Harbor.—Molybdenite.

Penobscot River, West Branch.—Apatite.

Piscataquis County, No. 9, R. 13.—Epidote.

Parsonsfield.—*Idocrase, yellow garnet, pargasite, adularia, scapolite,* galena, blende, copper pyrites.

Perry.—Quartz crystals, calc spar, analcime, apophyllite, agate, prehnite.

PERU.—Pyrites.

PRESQUE ISLE.—Quartz crystals.

RAYMOND.—*Magnetic iron, scapolite, pyroxene, lepidolite, tremolite,* hornblende, epidote, orthoclase, pyrites.

ROCKLAND.—Hematite, tremolite, *quartz crystals,* wad, kerolite.

RUMFORD.—*Yellow garnet, idocrase, pyroxene,* apatite, scapolite, graphite.

SACO.—Specular iron.

SANFORD.—*Idocrase,* albite, calcite, epidote, molybdenite, black tourmaline.

SCARBOROUGH.—Galena.

SEBEC.—Bog-iron ore.

SEARSMONT.—Tourmaline, *andalusite.*

SKOWHEGAN FALLS.—Rose quartz.

STANDISH.—Black tourmaline.

EAST SANGERVILLE.—Graphite.

SULLIVAN.—Iron pyrites.

SIDNEY.—Staurotide.

STOW.—Iron pyrites.

STREAKED MOUNTAIN.—*Beryl, black tourmaline, mica, garnet.*

ST. JOHN'S RIVER.—(upper part.)—Quartz crystals.

SANDY RIVER.—Gold.

THOMASTON.—Pyrites, galena, blende, bog maganese, *tremolite,* talc, argillaceous iron, *calcite,* arsenical iron, sphene, *hornblende,* graphite, *Thomsonite,* kerolite.

TOPSHAM.—Galena with blende, emerald, ferruginous oxyd of tungsten, apatite, garnet, magnetite, quartz crystals, chlorite, epidote, molybdenite, rose quartz, basanite, black mica, orthoclase.

TREMONT.—Green feldspar, (in the "Sea Wall.")

TURNER.—Bog-iron ore, pyrites.

UNION.—Galena.

MT. VERNON.—Gold.

WARREN.—Galena, blende.

WATERVILLE.—*Crystallized pyrites.*

WATERFORD.—Apatite, lepidolite.

WINDHAM.—(Near the bridge,) *staurotide,* spodumene, *garnet,* graphite, beryl, amethyst, *kyanite,* tourmaline.

WINSLOW.—Pyrites, (iron.)

WINTHROP.—Argillaceous iron, native copperas, pyrites, hornblende, staurotide, fibrolite, garnet, oxide of manganese.

Wiscasset.—Amethyst.
Woodstock.—Plumbago.
Woolwich.—Amethyst.
North Yarmouth.—Iron pyrites, beryl.
York.—Beryl, phosphate of iron, oxide of maganese.

Geology of Bethel.

Dr. N. T. True of Bethel, has carefully studied the rocks in that town, and has published an account of them in the Bethel Courier. We think that this description ought to be presented in a more permanent form, and therefore we reprint it. Another reason is the hope that its publication may incite persons in other towns to explore their local geology and preserve the details for the use of the survey. If twenty-five persons would explore the geology of twenty-five different towns, their results would assist us very much, even if they should label the rocks A, B, C, etc., provided they sent us the specimens corresponding to the labels.

The surface of the town is broken up by several mountainous peaks, the highest of which is about 2,500 feet above the level of the sea. This is situated in the west part of the town and has recently received the name of Anasagunticook, in commemoration of the tribe of Indians of that name on the Androscoggin river. Locke's mountain is on the north boundary and is 1,912 feet in height. Bear mountain, situated between Locke and Anasagunticook, might with more propriety be called *Bare* mountain, for its summit, to the extent of many acres, is entirely destitute of vegetation. Sparrowhawk, named after one of the proprietors of the town, is on the south-west part of the town. Walker's mountain is east from Walker's mills. Mt. Farwell is north-east from Bethel hill about three miles, and is nearly in the centre of the town, while Swan's hill is still farther east. Paradise hill is a gradual swell of land, extending from Barker's ferry through the village till it terminates in a ledge at a distance of about two and one-half miles from the river. This is situated in the centre of an amphitheatre whose boundary is enclosed by mountains, at whose base are valleys, and which forms a most interesting prospect. This hill is a frequent resort for summer tourists, as its summit can be reached by a carriage over an excellent road. Few better views can be found in Maine.

nasagunti-
Cook Mt.
2500.

These mountains are composed of granite, gneiss, mica, slate, and an occasional patch of impure limestone. They were originally covered with a heavy growth of pine, spruce, hemlock and hard wood, but a fire spread over them in 1817, which not only burnt off the wood, but also the soil, so that the surface of many of them is incapable of supporting vegetation.

These elevations are a continuation of the great Appalachian chain, which extends through the central portion of the State from the White mountains to Katahdin, and are of the same geological age and formation as the latter.

On the surface of Bear mountain are immense grooves running along in a north and south direction. They are on a more extended scale than I have seen elsewhere. Good granite for building purposes is found in various parts of the town. Occasionally a large boulder is found which has been transported from a distance, and which splits up into a beautiful form, and is of good quality.

On the swell of land on which the village is built are frequently ploughed out of the ground very curious boulders, one side of which is grooved and polished as if done by a graving tool. These boulders are unlike anything of the kind I have seen elsewhere in the State.

There is a bluff at West Bethel composed of pyritiferous slate, which is very strongly impregnated with sulphur. The action of the rains and frosts serves to decompose the rocks, by means of the sulphuric acid which is formed. Occasionally in sheltered spots, sulphate of iron, or copperas, is formed spontaneously. On a hot day in summer, the odor of sulphur is very perceptible.

Between the summit of Farwell's mountain and the Androscoggin there is a powerful vein of crystalized quartz which has forced its way through the mica slate and formed a breccia. It is several rods in width, and may be traced nearly a mile. No minerals are found in it save the peroxide of iron. The only vein of trap I have seen in town is about a mile west of the village, on Sanborn's hill. It is broken up in columnar fragments, the adjacent rock being wanting on one side so that it forms a wall. It contains augite and glassy feldspar.

On the summit of Mt. Farwell there is a small quantity of limestone, but of no commercial value.

On Bear mountain may be seen scattered over its surface globular masses of rock composed of yellow garnet, calc spar, hornblende and other minerals. The gneiss has been worn away, leaving these masses protruding above the surface like plums on the surface of a pudding. These globes are from a few inches to several feet in diameter. This existence is probably coeval with the gneiss, and they were formed in accordance with the ordinary laws of crystalization.

The town is not remarkable for good specimens of minerals. In the limestone on Farwell's Mt., a few very fine specimens of cinnamon garnet have been found. One now in my possession is the finest I have seen in the State. Pargasite, sahlite and calcareous spar, also abound there. Sphene, a mineral containing titanium, is frequently noticed in the gneiss. Some very fine specimens were obtained near the foot of Robertson's hill. The deutoxide of manganese is found on the Merrill farm near the bend of the river. Occasionally a beryl may be seen on the mountains. Tremolite and epidote are common in boulders. The manganesian and common red garnet are frequently seen. Phosphate of lime exists in the rocks on Walker's mountain, and at the railroad cut through Robertson's hill. I have never seen a boulder containing a fossil within the borders of the town. I obtained the last year some very good crystals of feldspar in a rock in the rear of the academy. Actinolite, egeran, graphite, talc, mica, tourmaline, hornblende, iron and arsenical pyrites, jasper, hornstone, octahedral crystals of iron and apatite, are common, though having no special interest. Boulders of a curiously distorted mica slate, are common. The drift evidently came from a great distance. In the bed of the Androscoggin river are boulders which have been brought down from the base of the White mountains through Peabody river. They are a compact and altered granite, and are worn into pebbles. Porphyritic gness is common in stone walls in this vicinity.

At the foot of Anasagunticook mountain is a chalybeate mineral spring which is fast becoming a place of resort for summer travellers. The water is impregnated with the carbonate of oxide of iron, lime, magnesia, and sulphuretted hydrogen. As the water is exposed to the air the carbonic acid escapes, and the iron is deposited in abundance. This can be collected and made use of by invalids, to great advantage. A half mile east of this is another singular spring which boils up through a bed of sand, giving it the appearance of a miniature volcano. Large quantities of gas, which however is nothing but common air, come up to the surface. Where the air comes from is a mystery, though probably through the crevices of the mountains.

The soil may be divided into high and low interval, meadow and rocky upland. The Androscoggin river runs through the town a distance of about seventeen miles, on either bank of which are fine interval farms. On Pleasant river in the west part of the town, is interval and meadow a distance of about three miles, and about the same distance on Meadow brook and Alder river, and one mile on Sunday river. The upland is usually rocky, but when cleared it has a strong and productive soil. The intervals on the other hand are overflown annually, and a fine rich sediment is left which greatly adds to the fertility of the soil.

The Androscoggin river evidently runs at a much lower level than formerly, and its channel is frequently changed. New beds of gravel are formed on one side, and banks on the other side are washed away. A marked change has taken place within a few years on the north-west side of Barker's island, where the channel is nearly filled up. These changes frequently take place during freshets, which rise suddenly and sweep down the river with great rapidity. Near the mouth of Alder river, when the Androscoggin river is low, the whole geological structure of the intervals may be seen in the different strata of sand, gravel, clay of different colors, owing to the presence or absence of the oxide of iron, and some thirty or forty different strata may be counted. There is but little clay in the town—two or three small deposits are all that are suitable for the manufacture of brick.

In 1857 occurred the greatest freshet ever known; it rose twenty-five feet. In 1826, the night in which the Willey family were destroyed, the river rose the highest and the most rapidly, since that time. In 1838 occurred an ice freshet, in the month of February, the only one, I believe, ever recorded in this vicinity. There had been a remarkably warm southerly wind for two or three days, which caused the river to rise suddenly and break up the ice, which piled up along the banks and on the intervals, presenting a curious appearance. A bridge, which had just been opened for travel at Barker's ferry, was swept away, as well as all the bridges on the river as far down as Brunswick.

On the stream above Dea. Edmund Chapman's mill, there is a cascade where large potholes have been worn into the solid rock by the action of water and pebbles.

The Androscoggin falls but a few feet in its course through the town. Boats can pass the whole distance at high water.

The banks of the river are divided into high and low interval. The high interval is never overflowed at the present time, and it was evidently formed by the early drainage of the country during the last great geological changes of this region.

Geologically speaking, the town is composed of the primary, or azoic series of rocks, above which the other series are entirely wanting till we arrive at the tertiary clay, diluvium and alluvium. From this it will be perceived that the soil is wholly granitic. It is deficient in lime, which, in the form of gypsum and slaked lime, is applied to the upland with great advantage. The intervals obtain a supply from the inundation of the river, which furnishes the necessary elements of a good soil."

PALEOZOIC ROCKS.

As previously stated, the Paleozoic rocks embrace the oldest fossiliferous formations, viz., the Cambrian, Silurian, Devonian and Carboniferous groups. No relics of animals or plants have yet been found in the Laurentian rocks, nor in the lower part of the Cambrian series. They are found sparingly in the Cambrian rocks, but quite abundantly in the Silurian system. It is yet a disputed question whether any of the Cambrian rocks in North America are fossiliferous. The question turns not upon the character of supposed fossils from a recognized Cambrian group, but upon the Cambrian or Silurian age of certain sparingly fossiliferous deposits. These rocks which all believe to be Cambrian (or Huronian) are azoic. As some of the rocks of Maine have been referred to this Cambrian group, we consider it necessary to state briefly the most important points of the controversy, and also to notice whatever has been written upon these rocks as developed in Maine. This leads us to consider the so called *Taconic System.*

In 1836, all American geologists were agreed that the oldest fossiliferous and sedimentary rock upon our continent was a purely siliceous sandstone, such as is displayed in great beauty at Potsdam, N. Y., whence it received the name of Potsdam sandstone. It was known to be a white or reddish sandstone, with no calcareous matter associated with it, and to contain only two brachiopod shells—the *Lingula*, and a supposed plant, the *Scolithus linearis*. A year or two later, Professor Emmons of Williams College conjectured that in the vicinity of his residence there were sedimentary rocks older than the Potsdam sandstone. The conjecture led to a careful examination, resulting in the announcement by him of the existence of a great system of deposits, sparingly fossiliferous, underlying the Potsdam sandstone, and therefore of more ancient origin. He published in 1844 a detailed account of this system, which he styled the *Taconic System*; from the Taconic Mountains in Western Massachusetts, where these rocks are largely developed. He was satisfied that the Taconic rocks contained a group of animals and plants altogether distinct from those contained in the Silurian rocks above. It is needless to trace the history of the controversy, or to allude to the variation in the nomenclature of the English rocks of the Cambrian and Silurian periods, but simply to state, in accordance with our classification of the formations, that the view maintained was essentially this, that in America the Taconic rocks form an independent system, underlying the Potsdam sandstone, and are the equivalent of the Cambrian rocks of the English Government Survey.

The oldest Taconic rock was called Granular Quartz; then in ascending order were the Stockbridge limestone, Magnesian slate, Sparry limestone, Taconic slate, Roofing slate and Black slate. Nowhere were these rocks to be found in their natural position, but all had been more or less disturbed by elevations, depressions and inversions of the strata. By various processes of reasoning, the other members of the group were all ascertained to underlie the Black slate, and this was seen distinctly in several places in Northern Vermont to underlie unconformably the Potsdam sandstone, which there was a little different from the normal rock in Potsdam, containing frequently considerable per cent. of carbonate of lime, and being without the Scolithus and Lingula.

These views were almost universally condemned, but the proposer of the system clung to them with great tenacity. His opponents maintained not that no Cambrian system existed in North America, but that the particular belt of rocks referred by Emmons to this age, along the western range of the Green and Hoosic Mountains, were only altered Lower Silurian formations; ascribing at first the Granular quartz to the Potsdam sandstone, the Stockbridge limestone to the Calciferous sandstone, the Chazy and Trenton limestones, and the various slates to the Hudson River group. This was the view of the opponents of the system in general.

Very recently a new impulse has been given to the discussion of the age of the Taconic rocks by the general change of views in regard to the age of the peculiar sandstones overlying the Black slate. A large number of fossils of the Potsdam type of life were found in these rocks near Quebec by Mr. Billings, the paleontologist of the Canada Survey; hence all were compelled to believe that this Quebec group is of the age of the Potsdam sandstone, instead of the Oneida conglomerate, to which it had been referred by stratigraphical comparisons. A trilobite of the genus *Conocephalites*, a Potsdam fossil, had been found in this sandstone in Vermont as long ago as 1847, and was then referred to this genus by Professor Hall, but its paleontological value had been set aside by the supposed clear evidence from superposition of strata of its Oneida age. The Conocephalites was not found in the typical Potsdam sandstone until 1857.

All now agree as to the Potsdam age of the sandstones overlying the Black slate. A question recently raised is whether this Black slate is not the Hudson River group, folded beneath the Potsdam sandstone. The Roofing slates have clearly been proved to be of about the age of the Potsdam sandstone, because they contain trilobites similar to those of equivalent rocks. Its equivalents are the Lingula flags of England, and the Primordial zone in Bohemia. The opinions respecting the precise age of the other rocks may be said to be in a transition state. It is probable that they are all Lower Silurian, but none of them as high as the Utica slate.

In no part of the world have the older forms of life been studied as carefully as in Bohemia. M. Barrande of France has beautifuly set forth the relations of the fossils to the different strata in Bohemia, in his recent great work. He calls the equivalent of the Potsdam sandstone the Primordial Zone of Life, because those strata in Bohemia contain the *first forms* of life there known. Such genera of trilobites as Paradoxides, Olenus, Conocephalites and Arionellus characterize the zone. It must be borne in mind that the term Primordial, as applied to these fossils, relates only to the Bohemian strata, as yet, because fossils have been found in England and Ireland of a still earlier period—the Cambrian. As long as the base of the Silurian system is fixed at the bottom of the Potsdam sandstone, not the most zealous defender of the Taconic system can maintain its entire equivalency to the Cambrian system, because the fossils of its slates are unquestionably the same with the Primordial forms of Bohemia.

With these preliminaries we pass to the description of the Paleozoic rocks of Maine, after first specifying those formations assigned to the Taconic system by Emmons. They are a portion of the clay slates of the central parts of the State, and the talcose schists, mica schists, quartz rock and limestone of Thomaston and vicinity. No fossils have been found in any of these rocks except in the clay slates; and these are now referred by the best authorities to the Lower Silurian. The only Taconic rocks left, then, are about Penobscot Bay. We defer expressing an opinion upon them at present. We quote here from the "Taconic System" the most important statements concerning the Taconic rocks in Maine:

"The slates at Waterville are of a fine greenish color, nearly as even bedded and as fissile as roofing slate, and very little liable to decomposition. They are, however, stained brown in some instance by the decomposition of pyrites which is disseminated in microscopic crystals through much of the rock. Among the crystals, I believe I can recognize also the octahedral iron. I consider the presence of these crystals important, inasmuch as they must have been formed by molecular action subsequent to the deposition of the rock. * * * Interlaminated with the fine greenish slates are calcareous bands, though by no means rich in calcareous matter. They are thin-bedded, and scarcely differ from the beds described in New York. I may go still farther, and say that we find here the same series of beds in the Taconic slate as in New York. I noticed in particular the coarse brecciated beds, similar to those formerly called *greywacke;* consisting, however, of a diversity of materials, as angular grains of quartz stained with chloritic matter, and disseminated carbonate of lime, which often disintegrates and falls out, leaving rather a rough spongy mass of silex or quartz stained with oxide of iron; and what I considered as quite remarkble, was the existence of hemitropic crystals of albite in the same coarse beds, under the same condition as in New York. These beds are traversed by thin seams of quartz, which give the mass a chequered appearance, looking at a distance like the sparry limerock. All the subordinate masses run parallel with the beds of the slate; when one is contorted, the other partakes of the same sinuosities.

"The points that I first examined in Waterville are not far from the centre of the range, the most important of which is that upon the banks of the Kennebec near the village, where the *Nereites* (*Nereograpsus*) are found. The slates are nearly vertical, with only a slight dip to the east: their trend is north 10 degrees east, varying, however, from this direction to north-east and south-west. At West Waterville, five and a half miles from Waterville proper, the same thin beds of slate appear, interlaminated also with silico-calcareous layers. The intervening country is moderately ridged with low hills, and the rock only appears occasionally, but enough of it may be seen to convince the most sceptical that it is but one continuous rock. One or two miles west of West Waterville, the taconic slate is succeeded by the primary schists with granitic veins, as in the country between Waterville and Portland. In the direction of their strike, they pass onwards to the Piscataquis river, where the fine roofing slates abound.

"In the position of the roofing slate in Maine, we have another fact analagous to what actually exists in New York, namely, the roofing slates are confined to beds subordinate to the taconic slate; and it is to be remembered, too, that as yet no slate fit for roofing has been found in the Hudson river rocks. * * *

"In the rocks of Camden I found much to support and sustain the views I had previously formed of the independent existence of a system of rocks above the Primary schists and below the Silurian system. That the relations of the rocks at this place may be understood, I have introduced a section which embraces the entire series in the order they occur. It crosses a tongue of land intervening between the harbor at the village of Camden, and a small bay or harbor formed by Goose river."

As this section is not copied we will describe it in such a way as to make it inteligible, using the facts but not the exact language of Emmons. The section is about three-quarters of a mile in extent from north to south, the rocks all dipping northerly from 15 to 40 degrees. Passing southerly we first see the magnesian slate, much wrinkled, and containing masses as well as seams of quartz: it is the north portion of the uplift, where the descent becomes rapid towards the river. Next is the Stockbridge limestone, cloudy, lumpy as it appears upon a weathered surface, intermixed with quartz, siliceous veins, talcose matter, etc. Its beds, when worked, offer veins of calcite, and imperfect veins of magnesian matter, which appears to result from the decomposition of feldspar. The soft matter contains dodecahedral crystals of calcite, with rough surfaces, which appear to have been formed in the soft matter after its decomposition. The same material is found in numerous places in the limestone at Williamstown, Mass. It is probably a porcelainous clay.

A trap dike traverses the hard slate, succeeded soon by a granite vein. Various fine and coarse slates appear holding the dike and vein. The coarse slate contains imperfect crystals of brown staurotide. About half way across the section a mass of quartz comes in, of a bluish color, very much like the granular quartz rock of Western New England. It is sixty or seventy feet thick, and appears to be distinct from another bed of similar rock soon to be met with. Next is magnesian slate. Then comes the second bed of brown granular quartz rock, portions of which are conglomerated. It is the principal mass of quartz, possessing all the characters of the same kind of rock in the typical localities of the Taconic deposits. It is interlaminated with a dark, fine siliceous slate. Portions resemble the talcose slates, in which, as in Rhode Island, a greenish granular mineral appears, more like epidote than anything else. Bands of yellow slate also appear, resembling those of Massachusetts which furnish the ochery iron.

Near the south end of the section, after rising up from the gorge of the river, and passing over the succeeding ridge some forty or fifty rods, a fracture appears, which brings the magnesian slate nearly in contact with the quartz over which it lies. It contains at this point also, imperfect macles. That the quartz is beneath this mass of slate, is proved by another fracture nearly at right angles to this one, and but a short distance to the westward, where both masses are brought up, the quartz being beneath, and bearing the slate with its peculiar imperfect minerals. The dip and strike in this case is changed to the west and north.

"The thickness of the limestone (noticed above), at this exposure, is about two hundred and fifty feet. The portions of the beds adjacent to the others are more or less slaty and impure. The stratification is extremely obscure; and were it not for interlaminated slate or other beds, it would be impossible to determine the direction of dip. It is difficult to discover the cause of such a condition, which is one that is quite common to limestones of this period. Even in the Massachusetts beds, the stratification is not always distinct. There is nothing peculiar to the main bed of quartz. It is interlaminated with a siliceous slate; and like all other beds, this is extremely barren of minerals. The dip is north, or conformable to that of the upper rocks."

The rocks composing Megunticook mountain, already described, are considered as forming a part of the Taconic system, as well as the rocks upon the Fox Islands. The principal difference between the rocks upon the islands and those upon the main land, consists in the greater metamorphism of the former, and as was supposed by the direct action of trap dikes.

We have in Maine, of the Paleozoic series, the Lower Silurian, the Upper Silurian, and the Devonian. No clear evidence has yet been afforded of the existence of any portion of the carboniferous system. We rather anticipate that in future, a Cambrian system may be established among our rocks.

LOWER SILURIAN FORMATION.

Those rocks most evidently of this age in Maine, form the fossiliferous portion of the clay slates, particularly of the region about Waterville. They may determine the age of the whole group, but we prefer not to describe them all as Lower Silurian at present. This opinion of the age of the clay slates we derive from the following remarks by M. Barrande, in a notice of the Taconic system:

Barrande's remarks on the Waterville Fossils.

"The problematic forms designated by Doctor Emmons as *Nereites*, *Nereograpsus*, *Myrianites*, etc., cannot be depended upon any more than the Graptolites, in determining the age of the *Taconic system*. In the first place, the nature of these fossils has not been certainly determined, though it now appears to be very probable that most of them represent the tracks of certain crustaceans and molluscs upon the mud. In the second place, Dr. Emmons at first attached great importance to these appearances, because he thought them exclusively characteristic of the Cambrian terrain, below the Lower Silurian. But the argument has now lost its strength, since similar forms recognized in Great Britain are ranged, without exception, in the Llandeilo and Caradoc groups, that is, in the second Silurian fauna. This fact is established by the table of the vertical distribution of Silurian fossils, published by Sir Roderick Murchison in the second edition of the *Siluria* in 1859. Finally, we ought to say that almost all the species figured by Doctor Emmons came from the schists of Waterville, in Maine, and that this locality has not as yet appeared to furnish any other fossil which can contribute to the determination of the geological horizon in a paleontological point of view."

Also the following:

"After this exposition of the elements of which the Taconic fauna is composed at the present day, according to Doctor Emmons, it is left for us to express our personal appreciation of their paleontological value. But first of all, we distinctly declare that we take into consideration only those fossils which have been found in the typical region of the Taconic system, that is, in the States of New York and Vermont. We will then take out of the list of species enumerated above, all the species found in any other States. We have come to this determination, for two important reasons:

"First. We wish to have nothing to do with the uncertainty of stratigraphical comparisons at great distances, and would simply compare those geological horizons which are admitted as Taconic, without demanding an incontestable continuity of the formations identified. We leave to whom it belongs, the care of confirming and strengthening those comparisons upon which our position at a great distance is defended, and express no opinion whatever concerning them.

"Secondly. The fossils that we leave out of consideration are certain small molluscs, graptolites, doubtful impressions called *Nereites*, or *Nereograpsus*, and some fucoids. * * * These forms, on the contrary, are analogous to those in the second or third fauna. They cannot be depended upon as guides in forming our opinions."

The following are the species found by Emmons in the Waterville slates: *Nereograpsus Jacksoni*, *N. Loomisi*, *N. Deweyi*, *N. gracilis*, *N. lanceolatus*, *N. pugnus*, *Myrianites Murchisoni*, and *M. Sillimani*. At first, they were all referred to the genus *Nereites*. They are supposed to be the tracks of articulate or molluscous animals, made when the rock was soft, and preserved distinctly when the layers became hardened. In Jackson's Report, they are described as branches of ferns of the genus Odontopteris, and as the remains of fuci or sea weeds. Such was also formerly the popular notion concerning them entertained by the people of Waterville and vicinity who saw the specimens. There is no cabinet in the State where a perfect set of these fossils can be found.

These fossils have been found at Waterville, Sidney, Winslow and Moscow, or in two distinct belts of clay slate. Those in the first three localities are in immediate proximity. Those from Moscow are a great distance from the others, and on a direct line are separated from them by a band of mica schist. The latter appears to belong to the roofing slate belt of Brownville, etc., prolonged to the Kennebec river. Other explorations will greatly enlarge the area of these slates, which we refer to the Lower Silurian series.

In mineral character, the Lower Silurian rocks of Maine resemble the Georgia slates of Vermont, which are the equivalent of the Potsdam sandstone. The various sandstones, limestones and slates of this period in the more western parts of the country, are not yet identified in Maine. It is singular that the rocks of this period, so full of fossils elsewhere, should be devoid of them in this State. We have hopes that the prosecution of the survey will bring to light many relics of life in these barren strata; and that ultimately the synchronism of the different portions of the clay slates of Maine, with the sandstones and limestones of New York, will be satisfactorily made out.

Flint Island, etc.

An excursion to Flint Island, in Narraguagus Bay, on the twenty-fifth of June, brought to light a sparingly fossiliferous rock so similar to the rocks of Potsdam sandstone age, that we were disposed to refer them to the Lower Silurian period, subject however to the dictum of the fossils. Those already found are not sufficiently characteristic to determine their age; consisting of an Orthis, encrinal joints and supposed corals.

The rock upon Flint Island consists of layers of flint and hornstone of different colors and textures. Some layers are flinty sandstone, and others are somewhat calcareous. Upon Ship Island, a short distance west of Flint Island, the layers are much less flinty, being occasionally indurated clay slates. On Flint Island, the strata dip about twenty-five degrees southerly. On Ship Island, the dip is only eight degrees. Adding together the thickness of the strata upon the two islands, we must have from 100 to 200 feet of strata.

There is no doubt but that these strata rest directly upon the syenitic rocks of the islands and main land adjacent. We imagine that a very low tide at Ship Island would show the junction of the two rocks. As the strata are so nearly horizontal no one can doubt their origin as sediments upon the syenite.

These islands form probably the south-west end of a Silurian basin, extending from Lubec and New Brunswick along the coast. No rocks of undoubted Lower Silurian age have yet been found in the basin, although the fossils from Foster's Island off Machiasport have a Lower Silurian aspect. At any rate we feel confident that the rocks upon these three islands are at the base of the Silurian coast formation, because the islands to the south-west and south of these are syenitic, and the strata dip away or rest upon them. The fossils at Foster's Island are mostly Rhynchonellæ, in a clay slate. They occur in the strata seams, which cross the cleavage planes at a large angle. So prominent are the latter planes of disunion that it is difficult to distinguish the lines of stratification, or secure good specimens of the fossil shells contained in them. The strata dip forty-five degrees north-westerly, while the cleavage planes are nearly vertical.

An immense number of trap and porphyritic dikes traverse the strata of Flint Island. Most of the fossils found were from the north side of the island. The rocks are here laid bare by the surf, and form a low precipice. We found here bunches in the strata greatly resembling the coral Chætetes; also a curious cylindrical stem, generally crossing the strata, reminding us greatly of Orthocerata. These stems were about an inch in diameter, with a mark in the centre. Most likely they are concretions. They make the rocks containing them very beautiful. Occasionally a layer exhibits pebbles and sandstones. One pebble of red feldspar noticed is three inches long. The calcareous sandstones on the south side of Flint Island have upon them what resemble the fucoidal markings of the calciferous sandstone of the Champlain valley. The west side of Ship Island forms a steep bluff, say sixty feet high. We counted upon it nine different colored bands of strata. We anticipate the discovery of the trilobite Paradoxides from the slaty layers. Flint Island is low, and has but one fisherman's house upon it. The rocks show only the shores.

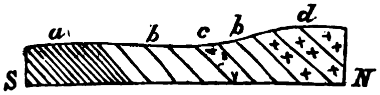
Upper Silurian Formation.

Owing to the preliminary character of our labors during the past season, we cannot define with exactness the limits of many of the Upper Silurian rocks of Maine. In Washington county, the limits of these rocks may easily be given. But in Aroostook county, etc., although the fossils from a belt of limestone are remarkably well defined, we cannot decide upon the boundaries of the whole group. Therefore our remarks upon them will be indefinite, and the rocks will be mentioned often by their lithological names. For the determination of the fossils we are indebted to E. Billings, Esq., of Montreal, who kindly afforded us valuable assistance in this department.

We will describe first the Upper Silurian deposits of Washington county. They occupy the towns along the sea-coast from Machiasport to Perry, but their area is largely taken up by intrusive trap rocks. Probably the metamorphic slates accompanying these strata are mostly of the same age.

Commencing at the south-west we find strata probably of this age in Machiasport, at the Point of Maine, underlying red sandstones. Fig. 2 illustrates its position. The fossils of this locality consists of species of *Modiolopsis*, *Avicula* and *Pleurotomaria*, two bivalve and one univalve shells, too obscure for specific determination. Their affinities seem to be with the Upper Silurian forms. We will give a few details respecting the position, variety and thickness of the different beds cemposing *a* in Fig. 2. The ocean appears at the south end of the section, thus prohibiting us from examining the very lowest beds. The slates upon Foster's Island already noticed appear to underlie these strata at the Point. The section is on the east side of the Point. We proceed northerly and ascend the strata in our section.

FIG. 2.



Section in Machiasport.

a. Upper Silurian, probably.
bb. Red sandstone.
c. Beds of limestone.
d. Metamorphic slates.
N and *S* are abbreviations for North and South.

a. At the extreme point of the promontory the rocks are mostly fine grained gray calcareous sandstones, almost as fine as clay slate. Owing to the presence of dikes of trap their position is irregular and does not correspond with that further north. The most reliable observation gave for the strike north 67 degrees east, and the dip 56 degrees north-westerly. We estimate about seventy-five feet thickness of these beds.

b. Ninety-nine feet of similar strata, running north 60 degrees east, and dipping 45 degrees north-westerly.

c. Forty-three feet of gray argillaceous limestones having ripple marks upon them. Strike north 70 degrees east, dip 40 degrees north-westerly.

d. Twenty feet of very tough slates, permeated by cleavage planes and joints.

e. Fifteen feet of slates or grits running north 60 degrees east, and inclined 40 degrees north-westerly.

f. Measures concealed for eighty-five feet topographically.

g. Fifty feet of argillaceous limestones, containing ripple marks at the thirty-seven feet layers.

h. Thirty-two feet of softer slates and gray siliceous limestones. The lowest stratum dips 35 degrees north-westerly, with the same strike as *e.* At the top of seven feet, there appears a dike of quartz five and a half feet wide, running north 15 degrees west, and standing perpendicular.

i. Eighteen feet of a dark calcareous slaty rock, containing Modiolopsis, Avicula and Pleurotomaria. Some of the layers are a soft thick-bedded limestone, apparently of economical value,—breaking with a beautiful conchoidal fracture.

j. One hundred and thirty-seven feet of dark slates and somewhat calcareous rocks, containing ripple marks at various levels. These marks appear to be in their normal position, showing that these strata have never been inverted.

k. Red sandstone, very fine grained, indurated, containing Aviculæ, twenty-five feet thick; and dipping 85 degrees westerly, with the strike north 10 degrees east.

l. The measures of rock are now concealed for a considerable distance, which we neglected to estimate.

m. Seventy feet of tough gray grit.

n. Twenty-two feet of greenish grit and red sandstone. The latter runs north 65 degrees east, and dip 50 degrees north-westerly.

o. Measures concealed for thirty feet topographically.

p. Three feet of gray shale.

q. Three feet of red sandstone.

r. Whitish sandstone, three and a half feet thick.

s. Seven feet of gray grit, slightly reddish.

t. Seven feet of red sandstone, with the strike north 60 degrees east, and a dip of 84 degrees north-westerly.

u. Gray sandstone of several varieties, ninety feet thick. It has the strike north 58 degrees east, and the dip of 45 degrees north-westerly.

v. Measures concealed for eighteen feet topographically.

w. Four feet of red sandstone.

x. Eight feet of limestone.

y. Twenty-five feet of red sandstone, dipping 60 degrees north-west.

z. Eighteen feet of coarse white sandstone, running north 60 degrees east, and dipping 56 degrees north-westerly.

aa. Eight feet of sandstone.

bb. Trap dike fifteen wide, perpendicular, running north 32 degrees west. It can be seen to extend for thirty rods.

cc. Coarse sandstone and breccia, weathering white, containing bunches and veins of epidote, and forty feet thick.

dd. Twenty feet of red and gray sandstones, running north 63 degrees east, and dipping 48 degrees north-westerly.

This brings us to the south side of Starboard's creek. Quite a large area is now occupied by alluvium, and the next rock seen to the north belongs to the Red Sandstone group. Hence we are unable to give any further measurements. The total thickness of the rocks thus far enumerated, cannot be far from 900 feet.

The Upper Silurian rocks appear along the coast in various places in Cutler, Trescott and Lubec. In the west part of Cutler there is a stratum of oval limestone pebbles curiously exposed by the washing of the waves. The pebbles have been worn smooth, and being of a light color are well set off by the black slate about them. They are scattered at various distances from one another, and being slightly depressed, to popular view, resemble foot marks. Hence they are known in the vicinity as the devil's tracks. Similar rocks occur in patches amongst the trappean rocks, so largely developed along the coast. Fossils are found in one of these belts near Lubec Head. A band of clay slate at West Quoddy Head in Lubec has a Lower Silurian aspect, yet must be referred to the upper group at present. The rocks upon the promontory terminated by Gove's Point, in Lubec, are largely Upper Silurian, and contain fossils. At Comstock's Point they are dark blue limestones, containing oval calcareous nodules. The fossils are numerous at Col. Trescott's farm, and at Lawrence's mill brook.

The same rocks are found in the vicinity of the Lubec lead mines. The fossils on a little bay north of the productive veins are *Orthis*, *Spirifera*, an *Orthoceras* and *Calymene Blumenbachii*. At Davis Point, south of the mines, the slates of this period appear containing a little calcareous matter. We find here two undescribed species of *Lingula* and a *Modiolopsis*. These shells are curiously distorted and frizzled frequently, by the forces to which they have been exposed. The Devonian sandstones appear on this point also, overlying unconformably the Silurian slates. In Perry, some other fossiliferous strata appear, running up Little River, and cropping out in one or two places from beneath the Devonian red sandstones. Pigeon hill is an example of the Silurian rocks. Its relations to the adjacent rocks are given in a section under the description of the Devonian rocks, Fig. 7. These strata are partly red sandstone and partly a metamorphic slate. The former is filled with beautiful *Lingulæ*, two species, and a *Modiolopsis*. Many persons might be disposed to think that the red sandstone of Pigeon Hill was of the same age with the other red sandstones in Perry; but the study of their relative positions shows that the rocks of this hill unconformably underlie those to the north; and that the two rocks are further separated by a trappean deposit, spread out very much in the manner of a stratified deposit.

The exact age of the Upper Silurian rocks thus far specified is not known, unless they may be of the same age with those in Pembroke. The two rocks are so connected together that it is difficult to separate anything from the Pembroke rocks, except those along the coast.

A very fine locality of fossils in Pembroke was discovered by Prof. W. B. Rogers of Boston, two or three years since, and by him compared with the Arisaig series of Nova Scotia. We collected a large number of fossils from the same locality, which enable us to state the geological age of the rock still more satisfactorily. Mr. Billings speaks as follows respecting them: "The fossils from this locality belong to the genera *Stenopora*, *Favosites*, *Petraia*, *Strophomena*, *Chonetes*, *Orthis*, *Rhynchonella*, *Spirifera*, *Retzia*, *Athyris*, *Atrypa*, *Modiolopsis*, *Avicula*, *Cyrtodonta*, *Murchisonia*, *Pleurotomaria*, *Platyostoma*, *Orthoceras*, *Calymene*, *Homalonotus*, and *Tentaculites*. The species determined are the following: *Favosites cervicornis*, *Strophomena rhomboidalis*, *Chonetes Nova-Scotica*, *Rhynchonella Wilsoni*, (variety,) *Atrypa reticularis*, *Orthis musculosa*, (?) *Avicula naviformis*, *Calymene Blumenbachii* and *Homalonotus Dawsoni*. The rocks of this locality are Upper Silurian, and belong to the Lower Helderberg Series of the New York Survey. They are nearly on the same horizon with those of Square Lake, and also with the upper part of the Arisaig Series of Dr. Dawson in Nova Scotia."

We find that Prof. Rogers has mentioned in the Proceedings of the Boston Society of Natural History three of the species enumerated above, also the following: *Discina tenuilamellata*, *Cornulites flexuosus*, *Tentaculites distans*, *Avicula Honeymani*, (?) *Beyrichia lata*, *Spirifer sulcatus*, *Leptæna rugosa*, *Orthis elegantula*, and *Modiolopsis ovatus*.

The Lower Helderberg rocks of Pembroke consist of slates, grits, and sandstones of various colors, textures, and degrees of inclination. They have in general a rather high north-easterly inclination. Their thickness is considerable. The best locality of the fossils is at the extreme south point of the town, near S. Mahar's house. The fossils may be found on the beach in fragments that have been washed from the ledges by the waves, or may be from the strata themselves. In the west part of Pembroke, the strata dip to the east. Another fine locality of these Helderberg fossils is in the east part of Pembroke, on Hardon Clark's farm. Essentially the same fossils are found here which occur at the south point of the town. The rocks near Pembroke village are more slaty than those containing the fossils. In the south-west part of Charlotte, in an indurated, and even micaceous slate, there is found a species of Orthis in considerable abundance, but its species cannot be safely determined until other fossils are found associated with it.

It seems difficult to realize that such indurated and apparently ancient rocks should belong to the Lower Helderberg group, especially adjoining granite. The fact shows us that we should be ready to assign a comparatively modern age to any altered rock, where the evidence of its age is satisfactory. It is probable that many of the trap-like rocks of this part of the State are of the same age. There are very few limestones associated with these Helderberg rocks in the south-east part of the State. In this respect, they differ from the Upper Silurian rocks in the more northern portions of the State.

There are seven other patches of the Lower Helderberg group, mostly limestones, in the north part of the State. One is at the base of Squaw Mountain at the south-west end of Moosehead Lake, adjacent to mica schist, and not unlikely of the same age. It is a calciferous slate, nearly vertical, containing the *Favosites Gothlandica*. The character of Squaw Mountain is not known. Another locality of the Lower Helderberg is on an island at the lower end of Ripogenus Lake. The rock consists of beds of gray limestone in slate, and appears both at the lower end of the island and on the opposite shores. The limestone contains the same coral as before. Some of the rock is brecciated. This locality is adjacent to novaculite slate and to granite. We cannot say whether these two localities are isolated parts of one belt, but presume that careful exploration will connect them together, as well as trace the rock a great distance north-easterly beyond the Penobscot.

The other localities exhibit a limestone as the characteristic rock of the group. Probably some of the slates and sandstones adjacent are of the same age. One locality was discovered by Dr. Holmes, the past summer, at Horse-shoe pond in No. 5, R. 8. It contains the characteristic coral in abundance, and there is a great cave in the limestone. Another limestone, probably of this age, is in No. 7, R. 7, near the mouth of the Seboois river. It is 90 feet thick, and has been partially altered by a trap dike. It may produce a marble when the demands of the county shall require its use. This bed probably extends down the East Branch of the Penobscot river, as we found boulders of the rock as far down as Winn, which did not appear to have been transported very far. It is curious that there should be three ranges of this limestone so nearly parallel to one another as the two just mentioned, and another one in the township east of the Seboois river, No. 7, R. 6, which will be noticed hereafter. They probably will indicate three different undulations of the strata.

The next belt of this limestone noticed is in Ashland, where it has been burnt for lime. This bed is largely fossiliferous, containing the *Favosites Gothlandica*, a *Zaphrentis*, *Strophomena rhomboidalis*, etc. It occurs in three places in this town, viz.: In the center, opposite the Hotel, a mile south and a mile north of the village. The rock at the southern locality dips 70 degrees westerly. But the comparison of all the exposures of the limestone here show that it forms the base of an anticlinal axis; consequently the rocks on the east and west sides of it are newer, that is, of Devonian age.

The last and most important belt of this limestone has been examined by Mr. Packard in two places; on the thoroughfare between Portage and Long Lakes, and on the west side of Square Lake. He has given in his report, the details of its position and structure. Very probably the shales and conglomerates associated with the limestone at the former of these localities, are of the same age as the limestones. The limestone at Square Lake is the most interesting, because of the fine lot of beautiful fossils contained in it. It is remarkable that there should be only one exposure of the rock in the vicinity. Mr. Billings was greatly interested in the fossils from this locality, and enumerates the following species. Those which are new, he will describe presently, in the Proceedings of the Portland Society of Natural History. There are two species of corals, *Favosites Gothlandica*, and a new species of *Zaphrentis*. There are three or four undeterminable species of crinoids. The following are the fossil shells contained in this limestone: *Strophomena*, new species like *S. punctulifera*, *S. rhomboidalis*, (*S. rugosa*, Hall,) another new species, *Rhynchonella Wilsoni*, (variety,) *R.* n. sp., *R.* another n. sp. like *R. acutiplicata*, *Spirifera perlamellosa*, *Atrypa reticularis*, *Athyris bella*, (*Navista bella*, Hall,) and *Platyostoma subangulata*. There are two new species of trilobites, a *Proetus*, and a *Bronteus*. In all, there are eighteen species.

There appear to be data afforded for tracing an exact parallel between the Upper Silurian and Devonian rocks of the northern part of Maine, and the typical localities in New York. By referring to the list of the different members of the group, given on page

150, it will be seen that there are conglomerates, shales, slates and limestones in New York. The same varieties are found in Maine; and to the geologist it will be a matter of intense interest, to work out the parallelism between the rocks of the two districts. The solution of the problem will have an important bearing upon the age of the metamorphic rocks of southern New England, a question of great difficulty and vast theoretical importance. Nor will its bearings upon Economical Geology be less important; for the valuable substances likely to be discovered are such as the settlers of a new country will need more than anything else.

The group of rocks in Canada East supposed to be of the same age with the Lower Helderberg series in Maine is called the Gaspe limestone. The name of their locality was applied to them because their synchronism with the Lower Helderberg series has not been fully understood. We hope that the examination of these rocks in Maine will connect the different groups together so closely that there will be no occasion for the use of the latter name.

It is proper to state here that in New York the Lower Helderberg series is subdivided into several smaller groups, each characterized by peculiar fossils, which subdivision cannot be followed westerly and southerly. The smaller groups are the following, in the ascending order: Pentamerus limestone, Delthyris shaly limestone, Encrinal limestone, and Upper Pentamerus limestone. May we not hope that these subdivisions will ultimately be discovered in Maine?

Rocks of probable Devonian and Silurian age.

Upon a geological map of Northern Maine, in Part II, there are grouped together slates of uncertain age, but probably Silurian in part, and Devonian in part. In our field explorations we were obliged to work in the dark, as it were. Not until the field work had ceased for the season, were we aware of the existence so distinctly of any of the New York series in Maine. Hence there are large groups of strata, generally unfossiliferous, whose age cannot be given without further exploration. In many cases they seem to be closely connected with the fossiliferous belts, and are probably of the same age—or the supposed connection of the known and unknown strata may not exist, owing to theoretical notions of the true arrangement; and lastly strata now thought to be azoic will yield fossils to future research. At present, the association of these unknown rocks by the common bond of uncertainty, is eminently appropriate.

A peculiar belt of mica schist of this uncertain character is found crossing the south part of Moosehead Lake. On one side, it is flanked by the Oriskany sandstone, and on the other by a supposed belt of the Lower Helderberg series. From our present disconnected observations of the position of all these strata, the schist would appear to be of the age of the Oriskany, or else intermediate between the two groups, as they are now known. Lithologically, the schist is more like the Devonian than the Silurian members.

A belt of rocks holding the same relative position to the Oriskany sandstone, viz: upon its south-east border, runs all the way from Moosehead Lake to Masardis, and then passes between known Devonian rocks to Castle Hill, and to an unknown distance further to the north-east. The rocks are mostly slates, often calcareous and sometimes very much like dark sandstones. These slates are most likely of Devonian age. At Grand Lake they seem to underlie unconformably the red sandstones of undoubted Devonian age. (See Fig. 13.)

The rocks north-west of the Oriskany sandstone group, between Chamberlain Lake and the Canada Road, belong to this uncertain belt. They consist mostly of clay slate, and have been examined about the head of Chesuncook Lake and on the Canada Road. It is not unlikely that this group of strata connects directly, west of Chamberlain Lake, with the immense development of clay slate on the northern boundary of the State. Their lithological characters are the same, and the age of both is doubtful, save that it is undoubtedly Paleozoic, and probably Silurian in part and Devonian in part.

Another group of the doubtful rocks are the calcareous slates so largely developed in the eastern part of Aroostook county. These rocks may be seen on the St. John river between the north-east corner of the State and the village of Victoria, in the township of Wakefield, N. B. The west line of the area of these rocks runs from the north-east corner of the State to Lyndon, thence in a nearly straight line to the Mattawamkeag river, through Presque Isle and Smyrna. A belt of similar slates, but less calcareous, is represented on our map; running in a north-east direction, between talcose schist and Devonian rocks, in townships 5, 6 and 7, in ranges 6, 5 and 4.

The mica schist, quartz rock, and conglomerate, with distorted pebbles in Weston, etc., will probably be found to contain fossils hereafter. Its relations are Silurian rather than Devonian. It forms quite an extensive formation, as seen upon our map, where all the doubtful groups just mentioned are also represented.

The Devonian rocks of Maine naturally divide themselves into two groups, differing in their lithological character. The group to be described first is clearly determined to be the equivalent of the Oriskany sandstone of New York; though differing from it in its general appearance. The other group of Devonian strata consists mostly of coarse sandstones and conglomerates, very often of a deep red color. Most of them are higher in the series than the Oriskany sandstone.

ORISKANY SANDSTONE.

Although the Oriskany sandstone of Maine is wholly located in the wild lands, its general character and some of its fossils are better known than those of any other fossiliferous rock in the State; for by a wonderful agency of nature, to be presently described, fragments of this rock, with fossils, are scattered all over the settled districts, south-east of the rock in place. Boulders of these fossils have been found along the sea coast from Saco to Eastport, some of which have been carried over one hundred and fifty miles. There is not a geological collection in the State in which specimens of these fossils are not found, and generally they are from boulders in the vicinity of the collection. The material of the boulders is a very fine grained sandstone, or sometimes compact quartz rock, enabled to resist decomposition easily by its great toughness. So few fossils from other rocks may be found in boulders in the settled counties, that persons who find any fossils in their fields in loose fragments of rock, may be sure that they came from this belt of Oriskany sandstone.

Dr. Jackson first pointed out the existence of this belt of fossiliferous rocks, without defining its position more definitely than the "Transition series," an old term nearly equivalent to the modern term Paleozoic. He discovered a fine locality of the fossils near Parlin Pond, in No. 3, R. 7, of Somerset county. The township is now called Parlin Pond. The following is his account of it:— "Between Jackman's and Boise's farms, on the side of the [Canada] road, half a mile north of Parlin Pond, I discovered a huge bed of fine grauwacke, [a sandstone with argillaceous or talcose cement,] filled with an immense number and variety of fossil shell impressions. The rock is of a fine siliceous variety, extremely compact where the shells do not abound, but presenting the most perfect casts of marine shells that I have ever seen. The width of the bed could not be exactly determined, as it is in part concealed by the soil; but I measured it for fifty rods, which is but a small part of its width. Among the fossils, I obtained the following genera: terebratulæ, spiriferæ, lutrunæ and turritellæ, beside which there are several other indistinct or broken fossils, which it is more difficult to determine. From the direction of this rock, it evidently crosses Moose River and the head of Moosehead Lake, and extends to the banks of the Aroostook [river], where we discovered it last year, and from it came all these numerous boulders and erratic blocks containing fossil shells, which we find scattered so profusely over the country, from the line above mentioned, to the outer islands of the Penobscot Bay, and at the mouth of the Kennebec River."

Prof. W. B. Rogers describes a boulder from Saco River containing these fossils, which he refers to the Devonian series. Dr. Jackson concurred in the same opinion.

Fossils from Parlin Pond and Moosehead Lake were examined by Mr. Billings, who reported as follows respecting them:

"The fossils from Parlin Pond belong to the following genera: *Strophomena, Chonetes, Orthis, Rhynchonella, Rensselaeria, Leptocœlia, Spirifera, Modiolopsis, Cyrtodonta, Avicula, Murchisonia, Platyostoma, Orthoceras.* The rocks are Lower Devonian, about the age of the Oriskany sandstone. The following are either identical or closely allied to Oriskany sandstone species.

*Strophomena magnifica,**
Orthis Musculosa,
*Rhynchonella oblata,**
Rensselaeria ovoides,
Leptocœlia flabellites,
*Spirifera arrecta,**
*Spirifera pyseidata,**

"Those marked with an asterisk are considered to be either identical or closely allied species. Those not so marked are identical. The rocks at Moosehead Lake are of the same age as the above. *Leptocœlia flabellites* is very common among the specimens. The trilobite from Webster Lake is a *Dalmanites.*"

We have large collections of fossils from this sandstone on Lake

Telos, Webster Lake, etc., which were not seen by Mr. Billings, and have not yet been determined. There are many genera among them not mentioned in the preceding list.

We need say no more respecting this Oriskany sandstone of Maine now, except to refer to its representation upon the map, extending from Parlin Pond to the Aroostook river in a general north-easterly course, and to the special details of the character and position of the rocks in Part II.

OTHER DEVONIAN ROCKS IN MAINE.

We will refer to four deposits of Devonian rocks in the northern part of the State before describing the red sandstones in Washington county, which are the best known of the series in Maine. The fossils from the loosely consolidated sandstones of this group are scattered along the East Branch of the Penobscot river. But we do not find them in place till we arrive at the Grand Falls in No. 5, R. 8. A very coarse conglomerate is at the base of this series; then succeed an extensive series of dark colored, fine grained slaty sandstones. These extend nearly to Grand or Matagamon Lake, where a fossiliferous red sandstone of considerable thickness caps the group. We found many boulders of a grayish white sandstone, highly fossiliferous, midway between Grand Falls and Grand Lake, which seemed to us to be near their parent ledge. Among the fossils in the boulders are the *Rensselaeria ovoides*, a characteristic shell of the Oriskany sandstone.

On the Seboois river there are similar sandstones, probably belonging to the same group as those on the East Branch. They probably extend to the Aroostook river near Presque Isle, as represented upon the map. Another series of sandstones and slates of Devonian age occurs at Ashland. Mr. Packard describes various sandstones and slates about the Eagle Lakes in Northern Aroostook county, which must be referred to this group. We have a large number of undetermined fossils from these groups. Billings recognized *Strophomena rhomboidalis*, *Rensselaeria avoides*, a *Platyostoma*, and a new species of *Dalmanites*, among a half a dozen specimens shown him. The fourth deposit of these sandstones is on Mars Hill.

Red Sandstones of Machiasport.

The relations of a group of red sandstones on the Point of Maine in Machiasport to a supposed Upper Silurian slate, is given in

Fig. 2. The area occupied by them is very small—it being a narrow strip crossing the south part of the promontory transversely. We are able to give a few details respecting the position and thickness of the strata.

The sandstones and conglomerates on the south-west side of the Point are indurated, and frequently are changed to jasper. Their general inclination is about thirty-five degrees northerly. The band of limestone is only ten feet wide on this side, but its appearance is a useful guide to us in tracing the different layers across the promontory. Some of the pebbles in the conglomerate are a foot in diameter. The sandstone is generally very fine grained.

Two islands west of Machiasport are partially composed of red sandstone; Lakeman's and Great Island. Upon the latter there are found a few fossil shells. The sandstones are in general greatly altered by the trap rock adjacent.

Upon the east side of Machiasport a few bands of red sandstone occur south of Starboard's Creek, but the great bulk of them are developed upon the north side, near a small collection of houses. We give an imperfect section of these rocks, but as complete as the nature of the case will admit. We commence at the first exposure of the sandstone. The extreme point on the north side of the creek is composed of trap. For a great distance beyond the rocks are concealed by alluvium. We proceed from south to north in the ascending order. It is a continuation of the section of Upper Silurian rocks given upon a previous page.

a. The first layer belonging to this formation is that of red sandstone. It is twenty-four feet thick and dips to the north-west 75 degrees.
b. About thirty-five feet of alternate green and whitish sandstone.
c. Measures concealed for a considerable distance by alluvium.
d. Thirty feet thickness of a firm sandstone, dipping 60 degrees to the north.
e. Measures concealed by a beach for five rods.
f. Twelve feet of a green schist.
g. Four feet of fine red sandstone.
h. Greenish sandstone, about twenty feet in thickness.
i. Three and a half feet of red sandstone.
j. Twenty feet of green fossiliferous (*Avicula*) sandstone, dipping 85 degrees north-west. Notice that *d* is an exception to the general dip.
k. Red sandstone four feet thick, isolated on a short beach of pebbles.
l. Thirty-one feet of a compact green sandstone, dipping 55 degrees northerly.
m. Red sandstone from nine to ten feet thick.
n. Semi-trappean rock of a green color, ten feet.
o. Red sandstone, eighteen and a half feet thick.
p. Variegated sandstone, four feet thick.

q. Ten feet thickness of white limestone; which is completely filled with fragments of an undeterminable genus of shells. This rock is composed of carbonate of lime 83.20, carbonate of magnanese 11.20, and of silica 5.60 parts. It may be wrought as a marble in small blocks.

r. Nineteen feet of red and variegated sandstone.

s. Twelve feet of white limestone, similar to *q*.

t. Twenty-eight feet of red and variegated sandstones; of which two feet thickness are highly indurated.

u. Trappean beds, indurated breccias and sandstones of unknown thickness, dipping 45 degrees northerly. These rocks pass into the metamorphic slates so common in Machiasport. The total thickness of the rocks mentioned above cannot be far from 550 feet. We do not know of any place east of Machiasport where these red sandstones reappear, unless it be in an unrecognizable form.

Red Sandstones of Perry and vicinity.

In the vicinity of Perry there is a fine deposit of red sandstones and conglomerates which indisputably belongs to the highest part of the Devonian series. Owing to the similarity of these rocks to the Connecticut River Sandstones, it was formerly supposed that they belonged to the New Red Sandstone, a Mesozoic rock overlying the coal. In consequence of this opinion extensive borings were made in them with the expectation of finding beds of coal in the underlying rocks; the explorers expecting to find the coal-bearing rocks immediately beneath the overlying formation. Even this expectation would be unauthorized if the sandstone belonged to the New Red Group, because we find frequently the rocks underlying the sandstones, as at Pigeon Hill and vicinity, where fossils of a Silurian type predominate. The coal rocks may be wanting even when the overlying formation is present.

In proof of the Devonian age of this group of rocks we may in the first place present the opinions of geologists. Dr. Jackson, who at first regarded these rocks as Triassic (or New Red Sandstone,) from mineralogical resemblances, now gives it as his opinion that they belong to the Old Red Sandstone or Devonian series, Professor W. B. Rogers was, perhaps, the first to refer them to the Upper Devonian, upon the ground that the *Cyclopteris*, a species of fern found in them, was related closely to the *C. Hibernicus* of the Upper Devonian of Scotland and Ireland. Prof. J. W. Newberry confirmed this view. Dr. J. W. Dawson of McGill College in Montreal has so wonderfully accumulated the evidence of the Devonian age of these sandstones that the proof of their Devonian age need be disputed no longer.

Prof. Agassiz, from an examination of a few *Calamites* from these rocks in New Brunswick, concluded that the rock must be Triassic. He thought the Calamites of New Brunswick had a more elongated stem, fewer vertical furrows, and a greater distance between the joints, than the Carboniferous and Devonian forms. These were almost the only plants known to exist in these rocks at the time of this examination. The vast number of species since figured and described by Dawson, all of a Devonian type, unless they more nearly resemble the plants of the Lower Carboniferous series, must surely outweigh the evidence of a few imperfect Calamites.

In the second place, we would refer to the character of the plants themselves, for proof of their Devonian age. For these statements, we depend entirely upon the researches of Dr. Dawson. In May, 1861, he published in the Canadian Naturalist, descriptions of 21 species of Devonian plants from the sandstones of Perry, Gaspe and St. John. Since then, he has pushed the investigation further, and is now prepared to describe at least 60 species of Devonian plants from these three localities, and also from the Chemung group of New York. It is not merely the fact that these species all have a Devonian aspect, but that the same species of plants which occur at acknowledged Devonian localities in this country, as at Gaspe and in New York, are also found at St. John and Perry. *Lepidodendron Gaspianum*, Daw., is found at Gaspe, Perry and in New York. *Psilophyton princeps*, Daw., is found at Gaspe, Perry and St. John. These are both thoroughly Devonian plants.

The *Cyclopteris Jacksoni*, Daw., is found both at Perry and St. John, and is compared, as above, with the *C. Hibernicus* of Ireland, etc. The *Sphenopteris Hitchcocki*, Daw., a new species common to Perry and St. John, may be compared with Unger's *S. petiolata* from the Devonian of Thuringia. A score of similar examples might be presented, were it necessary.

We collected a large number of fossil plants from the sandstones of Perry, the past summer, of which three species were new. This makes eleven well determined species from Perry. The following are their names: a *Sternbergia*, probably belonging to the *Dadoxylon Onangondianum*, Daw., an *Aporoxylon*, *Lepidodendron Gaspianum*, Daw., *Lepidostrobus Richardsoni*, Daw., *L.* a new species, a *Megaphyton*, *Psilophiton princeps*, Daw., *Leptophlœum rhombicum*, Daw., *Cyclopteris Jacksoni*, Daw., *C. Browniana*, Daw., and *Sphenopteris Hitchcocki*, Daw.

The *Sternbergiæ* are the remains of the pith of certain species of coniferous plants, so imperfect that it is impossible to determine even the genus of the plant to which they belong from the specimens alone. They appear as small bits of stems crossed by a multitude of fine parallel lines. The *Aporoxylon* and *Leptophlœum* are coniferous plants, like our pines and spruces. A *Sternbergia* of the latter occurs in Perry. The *Lepidodendron*, *Lepidostrobus*, *Psilophyton* and *Megaphyton*, are Lycopodiaceous plants, or similar to the ground and running pines, so common in our forests. The *Cyclopteris* and *Sphenopteris* were tropical forms. We hope in future to present figures of all these plants. We give here Dr. Dawson's descriptions of the three new species, which he has so kindly prepared for our report.

FIG. 3.

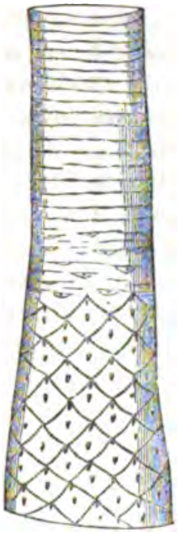
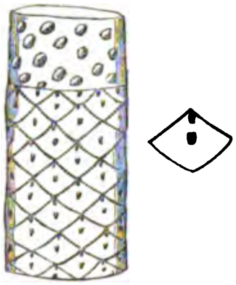


FIG. 4.

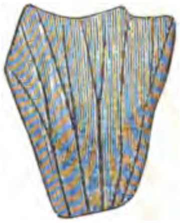


Leptophlœum rhombicum.

"1. *Leptophlœum rhombicum*, nov. gen. and sp. Stem cylindrical, with thin bark and a very large pith of the Sternbergia type. Surface marked with contiguous rhombic areoles, each with a single vascular scar a little above the centre. Decorticated stem with spirally arranged punctures in slight depressions.

The specimens of this plant, discovered at Perry by Prof. C. H. Hitchcock, consist of fragments of stems, not exceeding an inch in diameter, and considerably flattened by pressure. Traces of the bases of leaves are attached to some of them. In one specimen, represented in Fig. 3, the upper part of the stem is tapering, and shows indications of *distant* rhombic scars and a transverse wrinkling or jointing. This I suppose to be a younger and immature portion of the stem, showing the structure of the transversed wrinkled pith, as well as the imperfectly developed leaf scars. The plant was probably of rapid growth, with a very large Sternbergia pith, a thin woody cylinder, and a still thinner bark. In the arrangement of its areoles, it resembles such plants as *Lepidodendron tetragonum*, *Ulodendron minus* and *Lematofloyos crapicaule*, but it is evidently generically distinct from them all, in the enormous development of its pith and in the single vascular scars in its areoles. It is interesting to observe that in the younger portion of the stem, even when clothed with the bark, the appearances presented are simply those of a *Sternbergia*. Fig. 4 shows one of the rhombic scars enlarged.

FIG 5.

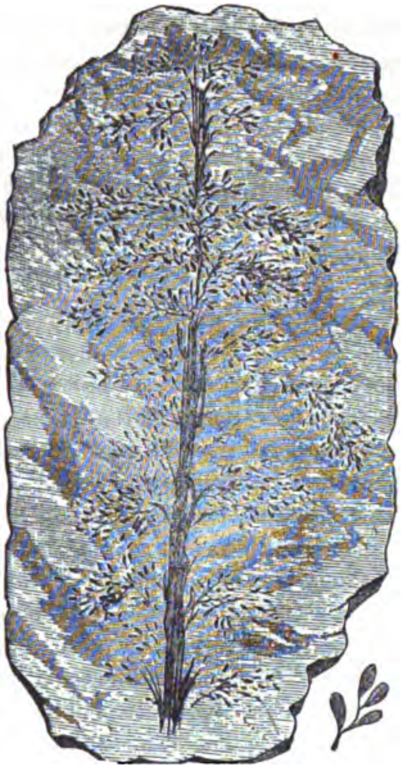


Cyclopteris Browniana.

Cyclopteris Browniana, sp. nov. Pinnules large, cuneate, with distant nerves once dichotomous and waved margins.

Several fragments from Perry and St. John have indicated the presence of a large Cyclopteris like leaf; but a specimen collected by Prof. Hitchcock is the first that shows its character with tolerable distinctness. It is named after Mr. Jethro Brown of Perry, one of the earliest and most successful explorers of the plant-bearing beds at that place.

FIG. 6.



Sphenopteris Hitchcocki.

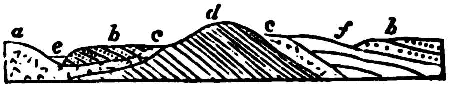
Sphenopteris Hitchcocki, sp. nov. Rhachis straight, stout, rugose; giving off branches or pinnae which ramify dichotomously, and terminate in minute obovate pinnules. Fig. 6 represents this plant of its natural size; and one of the pinnules, magnified, is represented on the right hand side.

This beautiful plant has the aspect of an excurrent stem rather than of a frond, and its nervation cannot be made out. It is evidently allied to such species as *S. petiolota*, Goeppert, *S. refracta*, Goep., and *S. devonica*, Unger, belonging to the group or subgenus *Davallioides* characteristic of the Upper Devonian and Lower Carboniferous. Scattered pinnules, apparently of this species, occur abundantly in the plant-bearing shales of St. John, N. B.

The above species are interesting and important additions to the Devonian flora, and they tend to confirm the views of the age of the Perry beds, expressed in my paper on the plants of Perry and St. John, in the Canadian Naturalist. J. W. D.

It becomes us now to describe the character of the rocks and the position of the strata, both at the locality of fossils spoken of, and of the whole formation. To illustrate the position of the plants, we introduce Fig. 7.

FIG. 7.



Section in Perry.

Explanation of the Figure.

a, Moose island, trap.
bb, Devonian sandstone.
cc, Trap, bedded.
d, Lingula sandstone, (Pigeon Hill.)
e, Cobscook Bay.
f, Locality of Cyclopteris, etc.

Moose Island, at the south end of the section, is mostly composed of trap. Crossing over the Toll Bridge, we at once discover a coarse, red sandstone, interstratified with red conglomerate, both loosely consolidated. Its resemblance to certain varieties of the Connecticut River sandstone is certainly very striking. The strike of these strata is north 25 degrees east, and the dip 25 degrees westerly. At the Union Tavern, a few rods from the bridge, the conglomerate crops out again. A short distance further, the rock is red sandstone, dipping 30 degrees north-west. Very speedily, trap rock succeeds, which can be traced around the east side of Pigeon Hill, thence northerly for several miles. It seems to form a great bed, having the same relations to the Upper Silurian and Devonian rocks as a stratified rock, as it crops out again at *c*, on the north side of Pigeon Hill, and preserves the same relations to the adjacent rocks. At H. Martin's house, there appears a bed of quartz, possibly a member of the trap series, with a dip to the south of 70 degrees. It is not represented upon the section. Arrived at Pigeon Hill, we find its base composed of Lingula beds of red and gray sandstone, dipping 35 degrees north. The top of the hill is composed of an imperfect siliceous slate, with the same inclinations as the strata beneath. A short distance north of Pigeon Hill trap occurs, and then the red Devonian sandstone. The locality of fossil plants is on the west side of Little River, about a quarter of a mile below the Perry Post Office. The plants occur mostly in a few feet thickness of gray sandstone, imbedded in the red rock. It dips 32 degrees east, or at right angles from the Silurian rocks beneath. Hence the plant-bearing rocks overlie the other strata unconformably.

This locality of fossils was discovered by Jethro Brown, Esq., of Perry, who discovered the Cyclopteris named after Dr. Jackson.

Mr. Brown has been a diligent student of the rocks in Perry, and gave us much valuable information concerning them. The borings for coal were made upon his farm. We are also greatly indebted to the kindness of the Messrs. Chadbourne of Perry, for aid in accomplishing the objects of our explorations.

At Point Pleasant, in the south-east part of Perry, the Silurian strata crop out from beneath the red sandstones, illustrating the complete uncomformablity of the two sets of strata, also the small thickness of the Devonian strata. They seem to have been spread over the Silurian rocks just as alluvium is spread over the solid rocks. As ledges frequently rise up from an alluvial country, so in this region the older strata frequently project above the more recent sandstones.

On the hill east of the Post Office, the red sandstone strata dip from 10 to 15 degrees east. The whole eastern coast of Perry presents a nearly continuous wall of red sandstone, dipping generally about 5 degrees east. At Lewis Cove, the precipice is 50 feet high. The wearing action of the sea makes this wall irregular; and in one case, a mass of red sandstone 38 feet high has been left standing alone away from the shore like a tower; whence it has received the name of Pulpit Rock. A few fragments of fossil wood may be seen in the strata adjoining this tower.

Passing across the St. Croix River, we find the same sandstone at St. Andrews. It there contains numerous fucoids, some of which are very interesting. We preserved specimens of an unknown fern, taken from the village of St. Andrews, which must have been extremely rigid, as it is left in the rock in an upright position. These specimens are quite numerous, and are invariably upright. The amount of red sandstone in St. Andrews is very small, much less than in Perry. A small patch of it appears as an outlier on the east shore of Robbinston. Other localities of the sandstone appear occasionally in the south-west part of New Brunswick, as on Spruce Island, Indian Island, Friendship's Folly, and at a point on which a Light-House is situated. These outlines seem once to have been connected together, before the waves washed away so much of the group. Possibly there was a large area once occupied by these rocks, extending beyond the city of St. John on one side, and to the island of Grand Manan on the other.

Although so much of this sandstone in Perry has been no more disturbed since its formation than beds of alluvial gravel, we find that on the western borders of Boyden Lake in Perry and Charlotte, this rock has undergone a change, being converted into siliceous slates and trappean rocks. These rocks are found all the way between this lake and Pembroke Furnace, dipping generally from 25 to 30 degrees northerly. At its southern extremity the dip is as high as 70 degrees, elevated perhaps by a mass of trap.

In the west part of Pembroke, we occasionally see ledges of red sandstone, but do not feel sure that they are Devonian. But there can be no doubt of the Devonian character of the red sandstones and conglomerates at Davis Point, south of the Lubec Lead Mines. The conglomerate there is largely composed of pebbles of trap and jasper, with rarely a pebble of granite. The red rocks rest unconformably upon the Silurian slates, the former having the strike north 20 degrees east, and the latter of north 60 degrees west. A gray sandstone on Gove's Point in Lubec probably belongs to this same group. Trap rock is beneath the most southern strata of sandstone, at both the Lubec localities, just as it is in Perry.

Comparison of the Devonian Rocks at St. John and Perry.

The connection between the Devonian rocks of Maine and New Brunswick, will soon become a matter of great interest. The sandstones in the west part of the province do not differ from those in Maine; but near the city of St. John the lithological character of the rocks containing the Perry plants is wholly different. With the exception of bedded trap rocks, no other portions of the strata are alike. They are white and gray crystalline limestone, hard shales and slates of various colors and qualities, quartz rocks, and indurated gray limestone. The plants occur in a highly argillaceous, black, somewhat plumbaginous slate, and are the same species as in Perry. The strata form an anticlinal axis, folding over syenite. Upon the edges of the Devonian rocks lies unconformably, dipping at a very small angle, the Lower Carboniferous conglomerate. The St. John rocks are of great thickness also. A section of Devonian rocks to the south-east of St. John, by Mr. Matthew sent to Dr. Dawson, may yet show that there exists in New Brunswick, upon the summit of the plant beds, a series of sandstones and conglomerates like those in Perry. At present, however, we have this problem before us to be solved: why should the rocks containing the same species of plants be so different in regions so near each other as Perry and St. John? Why should the conditions be favorable for the development of fine clay at St. John, while synchronous strata at Perry were being formed by a tumultuous current? It may be discovered that the upper beds at St. John are the proper equivalents of the Perry rocks. If so, we must suppose that these plants had an extensive vertical range.

Another interesting point in the comparison of these two localities is the confirmation of the Devonian age of the Perry sandstone. The lowest member of the Carboniferous system in New Brunswick overlies unconformably the equivalents of the Perry beds. This is true whether the clay slates or conglomerates be taken for the equivalent strata. Hence the certainty that the Carboniferous system does not occur in Maine is established. We did not desire to arrive at this conclusion, but the inference must be drawn.

This conclusion is further established by the comparison of the fossil plants of the Lower Carboniferous rocks of Massachusetts and these Devonian rocks. So many genera are common to the two groups, that Dr. Dawson was at first inclined to regard the Massachusetts coal plants as Devonian. The genera *Cordaites, Cyclopteris, Asterophyllites, Annularia, Sphenopteris* and *Calamites*, are common to the two formations, and many of the species are closely related. But there is a stratigraphical discordance between the two systems. This is generally considered as conclusive evidence of the destruction of the earlier economy of life before the later series was introduced. Hence we learn that although the floras of the Upper Devonian and Lower Carboniferous were very similar, they belong to entirely distinct systems of life, one series having become extinct before the other was created; and therefore that we need no longer expect to find beds of coal in Perry.

These facts need to be drawn out in detail as they have an important bearing upon grave questions. We believe that this is the first known instance of a decided break between the Devonian and Carboniferous systems in North America. The gradual passage of the Devonian into the Carboniferous beds of the west has been set down as a fact, and the inference suggested that there was no line of demarcation between them anywhere. These facts go to show that the Devonian and Carboniferous economies of life flourished independently of each other, certainly in the eastern part of the continent, if not in the western. This conclusion is the more interesting because of the similarity of the floras.

We have, therefore, at least three if not four discordances of stratification in the Paleozoic rocks, without including their position upon the rocks beneath. The first is below the Potsdam sandstones, separating the Cambrian and Silurian strata; the second separates the Lower and Upper Silurian, as at Gaspe; the third is between the Upper Silurian and Devonian, as is abundantly illustrated in Maine; and lastly there is the break between the Upper Devonian and the Lower Carboniferous.

The Devonian rocks of Canada East, with which the Maine beds must be compared, are mostly composed of sandstones, being 1,000 feet thick. They are called the Gaspe sandstones. Fossils characteristic of the Oriskany sandstone, Cauda Galli grit and the Upper Devonian, have been found among them, but we believe no attempt has yet been made to separate the series into groups corresponding to the New York members. The Devonian rocks are also developed in Nova Scotia, but upon a much smaller scale.

Between the Devonian and Alluvial periods, there seems to have been no deposition of strata in Maine. Her history during this period, is a total blank. It is not impossible but that portions of the coal formation may yet be discovered in the unexplored districts. Rocks which were formerly believed to belong to this series, as the Perry sandstones, and the supposed anthracite coal series in Northern Maine of Dr. Jackson, are now shown to be Devonian; and the presumption is that all the sandstones of Maine are fully as ancient. We found, however, a gypsiferous conglomerate on the St. John river near the State line, which may extend into our territory and prove to be more recent than the Devonian. It is of the same age as the Tobique red sandstones, whose age has never been determined, though they resemble the gypsiferous red conglomerates of the true coal formation.

Tertiary. We were almost persuaded, when in Rockland last summer, to believe that a small deposit of the age of the Miocene Tertiary existed there. In Vermont, and along the western flank of the Appalachian range in the Middle States, there exist numerous beds of iron ores associated with ochres and clays. They occur in connection with the Taconic rocks. In Vermont, fossils have been found in connection with these beds, showing them to be of Miocene Tertiary age. At Blackington corner, we saw a hematitic breccia similar to the Vermont and Massachusetts specimens, and as it was situated upon a similar limestone, we could not help exclaiming, here is our Vermont Tertiary! This hematitic mass was situated in a natural cavity in the limestone and consisted of a few pebbles cemented together by a great amount of hematite or the hydraus peroxide of iron. If it were found in abundance, it would form an admirable locality for the manufacture of iron. Without doubt this hematite was formed in the same way, and perhaps at the same time with the Miocene deposits. The underlying limestone is ferrugeinous; and as it decomposes, the carbonate of lime is dissolved, the iron collects together and forms nodules of hematite, or in the absence of molecular forces cements together fragments of rocks, making a breccia.

ALLUVIUM.

Under this head we include all the superficial deposits of Maine, whether in the form of boulders, gravel, clay, sand or soil. They constitute a geological formation. The agencies which have been at work during this period are still operating; so that the history of the alluvial period is yet incomplete. We find the termination of all the older periods sometimes indicated by an eruption of molten matter and the elevation of the strata; but the end of the existing economy of life and action will not appear so long as the world retains its present adaptations to the habits of her living races. What its end will be is known only to Him who controls our destinies.

The study of the superficial deposits may be termed *Surface Geology*. The names Drift, Diluvium, Pleistocene, Port Pleiocene and Alluvium, have been applied to the superficial deposits by different authors, and with different significations. We shall use the terms Alluvium and Drift only; the former being a general term to embrace the whole, and the latter being used to indicate its subdivision. The term Alluvium may denote either the deposits taken as a whole, or as the period when the strata were deposited. Alluvium then may be divided into four distinct periods of time, or into two more general divisions by the character of the deposits. Both divisions are useful, and are given herewith.

I. Drift.	*II. Modified Drift.*
1. The Drift period.	2. The Beach and Sea bottom period.
	3. The Terrace period.
	4. The Historic period.

The agencies which produced all the different forms of Alluvium were at work in each of these periods, and are still in operation. But at different times one agency has been more prominent than another. For example, in the second period, the agencies producing beaches and sea bottoms were the most active. Therefore the period is called the Beach and Sea bottom period. No special agency characterizes the present or Historic period.

The deposits in Maine in the first and last of these periods are the most noticeable. The beaches are very scarce, and the terraces are not numerous. The scarcity of the beaches is partly due to the general small elevation of the land above the ocean. We will first describe the facts and then state our theory.

Drift.

Unaltered or unmodified drift is a mixture of abraded materials, such as boulders, gravel and sand, blended confusedly together, and piled up by some mechanical force that has pushed it along over the surface. Yet in some places the materials are somewhat stratified and laminated, as if by water. In other cases, we find more or less of an alteration of finer materials, such as sand and gravel, with the coarser unstratified accumulations mentioned above.

No citizen of Maine will be at a loss to know what is meant by drift, as it is so common. Every bank of gravel dug into by the sides of roads that does not present alternating layers of finer materials, or may contain numerous boulders, is true drift. Sometimes only the piles of stones are prominent, many of which have been thoroughly smoothed and scratched.

A variety of the unmodified drift is the *boulder clay*. This is an unstratified mass of a stiff, dark bluish clay, containing rounded and striated boulders. It is commonly exposed on the precipitous banks of rapid streams in narrow valleys. It is not unlike portions of the fossiliferous clay along the sea shore.

This coarse, unmodified drift being the first alluvial deposit formed, underlies the finer sands and gravels of the later periods, and always rests directly upon the solid rocks. The finer materials were largely produced by the redeposition of the coarser varieties.

Dispersion of drift. It is a characteristic of drift, by which it is distinguished from disintegrated rock, that it has been removed from its original position, it may be a few rods or many miles. A fine example of this dispersion has already been alluded to in the removal of boulders of Oriskany sandstone from their ledges and their dispersion all over the State. We venture to assert that there is not a mountain in Maine, fragments of which will not be found scattered over the country to the south or south-east. The granite of the Katahdin region is scattered over the southern part of Penobscot county, and the rocks of Mt. Abraham and Mt. Blue may be recognized among the boulders in Kennebec county. So many persons have spoken to us concerning their dispersion during the past summer, that we doubt not this fact has been generally observed by the citizens of the State.

A curious fact in regard to this dispersion, is that the fragments are always found in the same direction from the original ledge. For example, we found no boulders of the Katahdin granite north of the mountain, while the country to the south was full of them. This fact may be of great service in the discovery of ledges whose fragments are valuable for economical purposes. The fragments will become larger and larger as we approach their source from the southerly side, when they will disappear entirely.

In some parts of the world the fragments have radiated in all directions from a common center, as in Switzerland from the Alps. But in Maine, and in North America generally, the course is uniformly southerly. If there be a centre of dispersion in our continent, it must be in a very high latitude in the Arctic Zone. There are in New England three general directions in which the boulders have been carried; to the south-east, to the south, and to the south-west. The first course is the more common in Maine. We can trace boulders in Maine for 150 miles from their source. How much further they were transported into the ocean is unknown.

Frequently the surface is almost entirely covered for many square miles with large transported blocks of stone, which are but little rounded. We can think of no remarkably large transported boulders in the State. On the west side of Grand Lake on the Penobscot river, there are immense masses of rock as large as houses, which properly have only fallen down from the ledges above, and do not come under the head of transported boulders. A large boulder in Windham on the south-east side of Canada Hill is poised so nicely that it can be rocked by the efforts of two men. Such boulders are called rocking stones. This one is of granite, eleven feet high, eighteen feet long, nineteen feet wide across the middle, fifteen and a half at the larger end, and nine feet at the smaller. It must weigh about 230 tons. It is on the land of Benjamin Craigue. Probably it has not been transported a great distance. In the east part of Avon there is a boulder of granite which measures 30 by 20 by 15 feet, equal to 9,000 cubic feet, or 643 tons. It was probably derived from the Mount Abraham range of mountains, several miles distant. There are doubtless examples of much larger boulders in the State.

One of the most remarkable effects of the drift action is the smoothing, rounding, scratching and furrowing of the ledges. Rocks that are susceptible of polish are sometimes rendered as smooth as polished marble. Universally the ledges over which the drift materials have passed, are more or less smoothed and rounded.

When rocks or mountains have been thus acted upon, we can easily see which side has been struck by the denuding force, because that side is rounded or embossed. In Sweden, this is called the *stoss* or *struck* side. The other is called the *lee* side.

Unless these smoothed and rounded ledges have been decomposed upon their surfaces, they are covered with scratches or striæ, usually parallel to one another, and indicating the exact course of the drift agency. Ledges of talcose and argillaceous rocks preserve these markings the most distinctly. Were the rocks of Maine to be laid bare, fully half the surface would show these marks of smoothing.

Course of the Striæ in Maine.

There is a considerable variation in the course of the striæ in Maine, which may be reduced to three general directions, viz.: from the north-west, the north, and from several degrees east of north. We have taken great pains to record accurately their directions, for the reason that the facts must be amassed together before any theory can be constructed out of them. The following are all the examples we can give. We give the direction from which the striating forces proceeded, according to pocket compasses:

Saco, north 18 degrees east, and north 5 degrees west.
Scarborough, north 10 degrees east.
Portland and vicinity, north 10 to 20 degrees west.
Woolwich, north 8 degrees west.
Winthrop, north 5 degrees east.
Readfield, north 25 degrees west.

Waterville, north 5 degrees east.
Mount Vernon, north 5 to 8 degrees east.
Skowhegan, north 6 degrees west.
Phillips, north 50 degrees west.
Salem, north 46 degrees west.
Top of Mt. Abraham, north 45 degrees west.
Farmington, north 10 degrees west.
Sandy Bay, (Canada line,) north 46 degrees west.
Foxcroft, north 30 degrees west.
Guilford, north 5 degrees west.
Dexter, north 15 degrees west.
Woodstock, north 20 degrees west.
Carthage, north 15 degrees west.
New Portland, north 10 to 15 degrees west.
North Monson, north 10 degrees west, and north 20 degrees west, intersecting.
Shirley, north and south, north 10 degrees west, and north 20 degrees west, intersecting.
Charleston, north 15 degrees west.
Newburgh, north 12 degrees west.
Hope and Appleton, north 45 degrees west.
Dresden, north 15 degrees west.
Wiscasset, north 10 degrees east.
Warren, north 20 degrees west.
Northport, north 10 degrees west.
Camden, north 8 degrees east.
Thomaston, north 5 degrees west.
Rockport, north 17 degrees east.
Ellsworth, north 15 degrees west.
Trenton, north 20 degrees west.
Hancock, north 5 to 50 degrees west, and north 15 degrees east.
Machiasport, east side, north 15 degrees west; west side, north 20 degrees west.
Foster's Island, north 20 degrees west.
Starboard's Island, north 32 degrees west.
Cutler, north 10 degrees east.
Lubec, north 40 degrees west.
Perry, north 25 degrees west.
Boyden Lake, north 53 degrees west.

Waite plantation, north 8 degrees east.

Amity, north and south.

w Limerick, north 13 degrees west.

No. 6, R. 5, of Aroostook, north 10 degrees east.

Patten, north 30 degrees west.

Passadumkeag, north 7 degrees east.

Benedicta, north 10 degrees east.

No. 3, R. 7, of Aroostook, north 10 degrees east.

Lake Telos, north 80 degrees east.

Chamberlain Lake, north-east part in two places, north 60 degrees west.

Chamberlain Lake, south side, north 70 degrees west, and north 50 degrees west, intersecting, also north 17 degrees west, and north 67 degrees west, intersecting.

Heron Lake, north 45 degrees west.

Churchill Lake, north 55 degrees west.

Near Fort Kent, north 20 degrees west, and north 63 degrees west.

No. 18, R. 6, of Aroostook, north 30 degrees west.

Two or three curious points deserve mention. At the Lubec Lead Mines, a series of striæ were observed upon the side of a perpendicular wall, following the course of the wall around a corner. The course of the striæ ultimately varied at right angles from their original directions. At several places upon the sea shore the striæ have been noticed below high water mark, and others were seen to run under the ocean at low water mark. The course of the striæ upon the lakes north of the Katahdin mountains have more of an easterly course than those to the east and south of the same mountains. It looks just as if the mountains formed an obstruction around which the striating agency operated, in preference to climbing the elevation. It is a curious fact, in the same connection, that the striæ are wanting on the summit of Katahdin. It appears also that there was another deflection of the course of the striæ in the valley of Sandy River. Mt. Abraham may have arrested the drift current on the north and turned it into Sandy River valley on the west, from which deflection it struck against the Saddleback Mountain range, continued to Mount Blue, and was then directed towards French's Mountain in Farmington.

It is unusual, however, that the striæ should alter their course for any topographical features. They cross valleys at every conceivable angle, and even if the striæ run in a valley for some distance, when the valley curves the striæ will leave it, and ascend hills and mountains, even thousands of feet high. Drift striæ are never found upon the south sides of mountains, unless for a short distance where the slope is very small. It is common to see different courses of striæ intersecting one another, as illustrated above.

We introduce here a letter written us by a stranger before we were commissioned. to examine the Geology of Maine, and as it relates to a part of the State unknown to us, it seems best to preserve it.

VINALHAVEN, August 20, 1859.

To CHARLES H. HITCHCOCK, Esq.—*Sir:* Knowing that you brought before the recent meeting of the Scientific Association, the subject of Glacial Agency, and that you probably would feel interested in any details of its action, I take the liberty to submit to you an account of what I am inclined to attribute to ice mountains moving over the rocky floor of this Island, previous to its final submersion. These scratched surfaces have not been noticed by any visitors to this town, that I am aware of.

This town is the more southern of the two isles called "Fox Islands," is about fifteen miles east from Rockland, and is separated from the other island by a navigable sound five miles long. Probably more than two-thirds of its surface is composed of gneiss; the balance of plutonic rocks, which form a rim around the entire town. The north island is formed of these trappean rocks, and so are all the islands above this. *They* do not abound in valleys—*this* does, having their trend from north to south, like the spine of the Camden Mountain on the west. The gneiss is of two kinds, coarse and fine, and is susceptible of an excellent polish. The cleavage of the coarse is perpendicular; of the other, horizontal, while their secondary "rift" is east and west; but I have forgotten the exact points, though frequently seeing the workmen taking them with the compass, in foggy weather.

The coarse gneiss is the highest, and rises in hills from one to three hundred feet. The other species seems to have been deposited in basins of the former; and in some places it appears as if the igneous rocks had much to do with its existence and position.

Now wherever the debris is removed on this island among the granitic rocks, whether in the valleys, along their sides, or on the shoulders of the highest hills, the scratches are distinctly seen in a direction *due north and south*, conforming, I presume, to the line of the valleys. In every direction,—and I have found them five miles apart,—they bear the same character of grooving, *fine* and *smooth;* and the microscope shows that the moving forces were exerted towards the south. At the principal harbor in the southern part of the town, "Carver's harbor," there is nearly an acre of flat rock exposed at every tide ebb; this immense surface is completely, and in many places, still beautifully striated and polished, notwithstanding the sea breaking in from the south, often holds in motion over them, vast quantities of sand. More than half the floor of a large cellar in the village, underlying the drift to the depth of seven feet, showed on the ledge the striæ; and a well dug recently near the foot of one of the principal hills, at the depth of eight feet, revealed the same phenomena on the fine gneiss, though dipping to the west at an angle of 25 degrees. The ledge looked after I had well drenched it with water, as if the polishing had just been done, not offering the slightest roughness to the fingers on sliding over the grooving.

On some of the hills where the dirt has been washed away, the scratches are seen; but on the naked rocks long exposed, we see only where the sliding forces have exerted their tremendous power, by the outline of the surface. For the coarser gneiss having been so exposed to the action of the atmosphere, the feldspathic crystals have loosened, and disintegration has gone on enough to merit from the workmen the designation of "rotten granite." Were these hills still covered by the boulder clays to the depth of a few feet, I am confident that the same phenomena of polish might be found on their summits. What the condition of the surface rock is at the north-west and north-east extremities of the Island, I know not; but I have found these striæ more than five miles apart, in different directions, on the gneiss. On the flat surface of a mass of greenstone in situ in the southern part of the Island near the granite, I found very beautiful striæ.

Now none of these scratches are deep. They are generally delicate and very regular, as if done by fine sand, with now and then coarse gravel, frozen into the under surface of a mass of slow and straightly moving ice. And ice itself might have had much to do with the polishing, as the hard ice of the Arctics would lead us to suspect.

It is worthy of note, I think, that in these peculiar marks of a power which has long since ceased to be exerted in New England, the striæ are due north and south, and not in the direction they are generally said to be; that they are found in all depressions of the rocky floor, whether *up hill or down*, and in the deepest dishes of the rock; that the boulders which have a polished surface, are mostly polished on one side, which is flat, and these rocks are not abundant, and that they are of the coarse and fine gneiss, and mostly lie near or upon the striated surface; that there is no granite in situ in the great valley of the Bay, northerly, within thirty or forty miles; that in approaching an ascending plane, the scratches are not vibrated out of the general direction, but are carried forward over high hills sometimes obliquely opposing the progress of the moving power; that the contour of the hills seen in profile, is that of an easy curve towards the north, with bold mural faces looking out upon the south; and that even *close up to these vertical walls*, the striæ begin, and are propagated in a straight line southerly.

I intend to follow up these examinations during next month, in other parts of the Island not yet examined; but before a thorough search is made, with compass and excavating tools, one ought not, perhaps, to hazard an opinion concerning the cause of these remarkable scratches.

I am, sir, respectfully,
JOHN DELASKI.

The embossed and striated rocks show that in some instances the drift has been transported from lower to higher levels. On the northern slopes of mountains the striæ run from the bottom to the top, the course being shown by the stoss side, without essentially changing their parallelism. The tops of most of our mountains are covered by fragments of rocks different from those composing the mountain. The only exception to this statement in Maine that we have seen is the summit of Mount Katahdin.

This exception may show us the vertical limits of drift. Heretofore it has been supposed that no mountain in New England had escaped denudation by the drift agency, except the summit of Mount Washington. That would leave Katahdin exposed to its force, as its summit is about 400 feet lower than the highest point of Mount Washington that has been affected. There is no objection that we know of to the supposition that Katahdin may have been submerged, but that by accident its summit was not struck by the denuding force. Katahdin is unusually isolated from all other ranges, so that it is not strange that it should so nearly have escaped the general abrasion. As to the horizontal limits of the drift, it may be said that there is no part of Maine free from it.

Rarely the boulders derived from a single locality are arranged in a right line, or in several lines streaming off in the direction in which the drift agency operated. They may be called *trains of boulders*. Such boulders are not much rounded, and they lie upon the surface of the common drift, not being mixed with it. The trains pursue a strait course without reference to hills and valleys. Two examples of these trains have been observed in Maine, one in Bethel, described by Dr. True, and the other is in Wayne, according to Dr. Holmes. The boulders in Bethel are very curiously shaped; and it is not easy to say how those shapes were produced. The latter train, we believe, is a mile or two in length.

We find among the records of the Portland Society of Natural History an account of the boulders referred to by Dr. True, and also a letter concerning them by my father sent to Dr. True, both of which we produce here with the permission of the society:—

"I wish now," says Dr. True, "to call your attention to a collection of boulders of a peculiar character found in Bethel, in this State. These boulders are scattered over the surface of the soil for several square miles. On one side may be seen grooves, scratches, strial and polished surfaces. Nothing of this is seen on opposite sides of the same rock. The opposite surface is usually angular, as if it had not been subject to abrasion since its detachment from the parent rock. Frequently, as in the specimens before you, may be seen sharp angles formed by a different presentation to the abrading surface. Sometimes the grooves present an undulating surface, as if they had been subjected to a tremulous movement from the impending mass. One of these is a beautiful specimen of graphic granite, finely grooved and polished. Although the specimens are exceedingly varied in appearance, yet their appearance must be attributed to the same general cause.

They evidently have been transported from a distance beyond the Mount Washington range. There is a freshness in their appearance, as if they had been grooved yesterday. They present no appearance like rocks on the sea-shore, which have been exposed to the action of water. They are composed of granite, hornblende and gray wacke slates. Having as briefly as possible described them, we are naturally led to inquire what has caused their peculiar appearance.

"President Hitchcock, to whom a fine specimen was sent during the present winter, has suggested that they might have been frozen into icebergs at several successive periods, and thus presented their several surfaces at different times. But with all due deference to his opinion, and after a review of the whole subject, I can hardly coincide with his suggestion. If this were the fact, opposite faces must in some cases be the result, which has never been the case according to my observations. Besides, should they not be found in other localities? Might they not rather have been formed by the stranding of an iceberg, which by its oscillations produced just the effects we have described? The boulders are not limited to a few specimens, but may be gathered by thousands over a limited space, and are easily recognized. Or may they not have been the graving tools themselves of some iceberg, which from some cause dropped out and remained undisturbed till thrown out of the soil by the plow? In all probability most of the rounded boulders generally exposed to view have received this form *since* leaving their bed in the ice, and this apparent anomaly of the Bethel boulder *may* prove to be the general rule of action, and not the exception."

The following is the letter referred to :—

AMHERST, MASS., Jan, 16, 1854.

Dear Sir: I ought to have acknowledged ere this the receipt of your letter and the box of specimens, for which I am greatly obliged.

I am very much puzzled with the specimens. They are different from anything I have seen, and deserve careful study. The grand point of difficulty is to account for the boulders' being held in so many different positions in order to be scratched — or rather grooved; for the striæ are different from those in common rocks. I can think of no possible theory except that of supposing the boulders frozen into icebergs, which were carried along and mixed pell-mell by the waters, grating against the bottom and one another. And it would seem that they must have been frozen in again and again. Or possibly the boulders were fixed in the ice at the bottom of the water, and then grated by the icebergs and detritus driven over them by the current.

But I will not speculate. Rather would I, if it were in my power, visit you and examine the phenomena. I trust that you will do it, and arrive at a correct explanation. It is a new phase, it seems to me, of drift action. * * * *

With great respect,
Most truly yours,
EDWARD HITCHCOCK.

Traces of Ancient Glaciers.

The drift agency must be distinguished from the glacier. Glaciers are rivers of ice descending from the regions of perpetual frost, to levels below the usual snow line, either in the temperate or tropical zones. They are properly streams filled with the overflow or *waste* of the vast snow fields occupying the higher regions. The ice has a certain plasticity, so that it will yield to the irregularities of descent like a stream of water, only much more slowly.

Glaciers formerly existed where none are now found, both in glacial regions and where the climate was formerly much colder than at present. We have found traces of ancient glaciers in Massachusetts and Vermont, which are described in the Proceedings of the American Association for the Adv. Sci. for 1859. We there suggested that similar traces might be found in Eastern New England, and are now ready to report progress in accordance with this prediction.

The markings left by glaciers are very similar to those left by drift, so much so that a theory has been suggested that the whole of the drift was one great glacier. The following are the most important distinctions between them: 1. Glacier striæ often differ widely in direction from drift striæ. The latter may be referred to the three general directions given above, while the former cannot be referred to any general course; they may coincide with or cross at any angle the markings of the drift. 2. Glacier striæ occur only in valleys, while the drift striæ overtop mountains; or, when found in valleys, may cross them obliquely. 3. Glacier striæ descend from higher to lower levels. Drift striæ as frequently proceed from lower to higher levels, often climbing mountains several thousand feet high. 4. Drift deposits are spread over the surface promiscuously. The detritus of glaciers is found only in valleys, forming moraines.

The only examples of glacial markings in Maine, we have seen, are on the St. John river in its upper portion, though we doubt not they will be found in Oxford and Franklin counties. Above the Lake of the Seven Islands, on this river, we noticed no glacial markings, unless the scratches upon the pavement of boulders are to be referred to them. The bed of the river is full of stones, and upon the banks below high water mark they are as firmly set as paving-stones in the streets of a city. The scratches are not as constant and distinct as those of the glacier below, and may possibly have been formed by ice freshets in the spring of the year. Descending the river to No. 14, we find a ledge which has been struck by a force descending the river, as the stoss and lee sides plainly show. The course of the striæ is north 65 degrees west, the stoss side being on the south-east. A similar example occurs near the mouth of Black river, where the course of the striæ is towards north 60 degrees west. The country above Black river being quite level, is not so well adapted for the existence of a glacier as the region below, where high mountains crowd the river on both sides.

At the mouth of Little Black river the upper side of the ledges is uniformly the struck side. Some of the ledges are covered with both drift and glacial striæ, the former coming from north 60 degrees west, and the latter running down the river north-easterly. A mile above the mouth of the St. Francis river the glacial striæ run down the river with the direction north 47 degrees east. Near the village of St. Francis the two sets of striæ appear again, the drift with the directions of north 60 degrees west and north 20 degrees west, and the glacial with the directions of north 16 degrees east. This is the course of the river around a curve. The former are here the most prominent. In the township below Fort Kent striæ appear running north 30 degrees west. One of the finest exposures of the glacial striæ is in Dionne, where the river makes a great bend and pursues a northerly course. The striæ change with the river and run north 20 degrees west, or directly opposite to the normal course of the drift in the vicinity, the force having gone northerly instead of southerly. We observed nothing of the glacial markings below this township, of importance. In fact, the glacial and drift markings could not be distinguished from each other below the Madawaska settlements.

We would remark that the evidence for an ancient glacier is not so strong on the St. John river as in the western part of New England. Some might contend that the immense ice freshets in the spring would be sufficient to explain all the phenomena. On the other hand, the objection to glaciers in northern Maine would be less than in Massachusetts on account of the colder climate.

Sea Walls.

A form of coarse drift produced at the present day arrested our attention at Starboard's Creek and Tremont. It consists of a long embankment of smooth boulders, without gravel, arranged on the sea-shore at high water mark. When the great storms in the spring prevail off the coast, very powerful waves transport from the bays multitudes of boulders, some of them a couple of feet in diameter, as far as their agency extends. Hence, the work of years has accumulated in various places quite large embankments, which are popularly called sea-walls, They are often shaped like the glacis of a fortification, the side next the sea having a small slope, and the side next the shore being quite steep.

The sea-wall in Tremont is at the South-West Harbor. It is often fifteen feet high and over a quarter of a mile in length, but as it appears in several bays, their whole lengths added together amount to more than a mile. It is sometimes ten rods wide. The wall near Starboard's creek is smaller, and is composed of pebbles, much like a beach. One of them we should judge to be six feet high and twenty-five rods long. Another one is a quarter of a mile in length. We hope that those persons who are familiar with other examples of these walls in the State will communicate with us.

MODIFIED DRIFT.

Whenever there is evidence that the coarse drift has been acted upon by waves or currents subsequent to its production, whereby the fragments have been rounded, comminuted, their striæ removed and those of different sizes sorted and arranged in different layers, we call the mass *Modified Drift*. In Maine it occurs in the form of moraine terraces, horsebacks, sea-beaches, sea-bottoms, marine clays and terraces.

Moraine terraces are generally accumulations of gravel, boulders and sand, often arranged in heaps and hollows, or conical and irregular elevations with corresponding depressions. They somewhat resemble the moraines of glaciers, differing from them by their stratification and existence in localities where glaciers could not have formed them. From their affinities with both moraines and terraces the name of moraine terrace has been applied to them.

We have not found these mounds very common in Maine. Their place seems to have been taken by the "horsebacks," which are very rare in other parts of New England. The moraine terraces are frequently associated with the horsebacks, insomuch that at times we have been disposed to consider the longer horsebacks as a narrow strip of moraine terraces. In the most northern tier of towns in Washington county we observed a few of these mounds connected with short ridges; being arranged somewhat in a line parallel with the ridges, on their south-west side. The material of these mounds is clean coarse gravel. Connected with the horsebacks in the southern part of Aroostook county, and also in Houlton we found a few moraine terraces. We doubt not that further exploration will show us many of these curious mounds in all portions of the State, particularly the western. Mr. Houghton describes in his notes a few of them on the south side of a pond in Plymouth.

Horsebacks.

A curious class of alluvial ridges are found in great abundance in Maine, and scarcely occur out of the State, which are known by the provincial name of *horsebacks*. They are found mostly in the unsettled districts, and have never been carefully explored by geologists. We are not ready to theorize upon their origin until more details of their structure and distribution are known. In general they may be described as narrow ridges of coarse gravel and sand from thirty to forty feet high, situated in a level country, with sometimes an undulating summit, and the two ends are of nearly the some elevation above the ocean. With this general statement, we proceed to specify their localities so far as they are known to us.

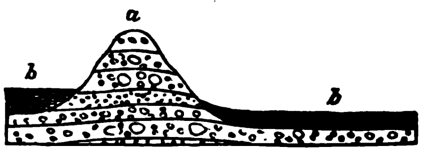
The horsebacks are not common in the western counties. There is said to be a short one in Belgrade and the west part of Standish. Between Rumford and Woodstock there are high ridges of granitic pebbles a mile or more long, which are called whalebacks. In Charleston there is a horseback running north 15 degrees west, corresponding with the course of the drift striæ in the neighborhood, which is four miles long. On each side of the ridge are peaty swamps of great extent. A branch strikes off from this ridge in a curvilinear direction.

Mr. Houghton gives the following account of a horseback in the south part of Plymouth: "The horseback that runs through Plymouth pond, over which the road passes, is interrupted just south of the pond by several gravelly knolls, presenting an interesting field for investigation. One has an abrupt hollow in the top of it, extending, I should think, to near the level of the pond, in the bottom of which is a clayey puddle. To the south of these the horseback is continued with greater height and steeper sides, and is said to extend uninterruptedly to near the center of Troy. It is interrupted in the north part of Plymouth pond, and its place as a road is supplied by a floating bridge. It is hardly discernible to the north again till we arrive on the north side of Plymouth hill, which has cut across it. From this hill it extends to Newport pond. Its general direction is north and south. It runs a few degrees west of north in Plymouth pond. Its total length so far as examined, is ten miles. In North Dixmont there is a large meadow on the west side, and a mill stream on the east side of the ridge. Upon the east side of the ridge there is an unfailing mineral spring eight feet above the mill stream. It appeared to me that this spring could not have come from the meadow upon the west side of the ridge, because it is higher up. What, then, is its origin?"

A beautiful horseback, with an easterly course, is located in the corners of Beddington, Townships Nos. 29 and 22. It is forty feet high or more, and is two miles long. It is said to run out from the lee side of Lead mountain. Several smaller ridges are adjacent to the principal one. A very large though not long horseback extends from East Machias to No. 18. We were informed of a very long horseback on the west side of Penobscot river, commencing at Orono, and extending through Oldtown, Alton, Argyle, Edinburgh, Howland, Maxfield and two No. 3 townships to the west branch of the Penobscot. This would make the horseback fifty miles long. Part of its course would lie along Seboois stream.

The best known example is found between Weston and Houlton. It is said to commence in Weston, or No. 9 of Washington county. The road strikes it in the north part of Weston, where it runs north 70 degrees west. It soon changes to north-west and south-east, and presently to near north and south. There are a number of zigzag curves in the horseback where the road passes over it. Its height in Weston varies from fifteen to thirty feet. Several times it is cut through by streams, showing the ridge to be more ancient than the streams. A short distance west of Houlton the same horseback reappears, being in one place ninety feet high. The material of the ridge is sand, gravel and boulders indistinctly stratified. The sand of this horseback is black, and there is no similar sand anywhere else in the county south of Houlton. Fig. 8 shows the general structure of these horsebacks. *a* is the ridge, and the strata composing it are seen to be nearly horizontal, but slightly curved like an anticlinal axis. The ridge is entirely composed of loose materials, the solid rock appearing beneath it. *b b* represent the relative position of the peat and loam, so commonly found in swamps, upon the sides of the horseback. The ridge under consideration extends north of Houlton to Littleton, and perhaps farther. This gives it a length of about forty miles.

Fig. 8.



Section of a Horseback.

We rode over a large horseback in Enfield for an eighth of a mile, and the ridge extended further. A smaller one runs from Lincoln into Enfield. Rev. Mr. Keep informs us that there is a horseback extending from the Indian township at Mattawamkeag Point to Bradley, on the other side of the Penobscot; another in Nos. 2 and 4 of Penobscot county west of Sisladobsis Lake, and a third in Levant and Corinth. In the south-west part of New Brunswick there is a horseback five miles long, nearly parallel with the course of the St. Andrews and Quebec Railroad. Its north end is at the station McAdam, and is higher than the other end according to railroad measurements. North-east of Trafton's hotel in Golden Ridge there is a horseback four miles long. Another a mile in length is located to the north-west of the same hotel. Commencing at the mouth of the Big Spring Brook in No. 5, Range 8, on the west side of the east branch of the Penobscot, we found a horseback running north 40 degrees west. Following it for more than a mile it terminated, and at its northern end its course is north 27 degrees east. Nearly opposite the mouth of the Alleguash river there is a long ridge resembling a horseback, which we did not have time to examine. This makes a total of seventeen horsebacks that are known to exist in Maine. We know of only three localities of them out of the State.

Nothing similar to these ridges have been described out of New England, unless it be the escars of Northern Europe. These consist of pebbles of carboniferous limestones heaped into narrow ridges forty to eighty feet high and from one to twenty miles long, probably formed in the eddies along the margins of opposing and conflicting currents, which piled up the materials from each side. We have not felt satisfied that this explanation will account for the origin of the horsebacks. It is difficult for us to see how a single ridge can be formed by these currents. Two currents flowing side by side would produce three ridges instead of one. A strong current confined to a narrow space might deposit such a ridge; but where are the barriers which placed the current in these circumstances? Can we conceive of ice barriers fifty miles long? Surely any other species of obstruction would have remained, and we should have had a gravelly bank lying against a long hill. Then a current would naturally deposit the heaviest stones first, which is not the case with the horsebacks. When a thorough exploration shall be made of these ridges, then we may be able to theorize upon them. We want to know the following things: 1, their number and general distribution through the State; 2, the exact course of each ridge, with all its zigzags and curves; 3, their height at every variation of altitude, particularly their height at the upper end as compared with the lower end, if there is any difference; we want to know whether they are higher in the middle than at either end; 4, the materials of which they are composed, their arrangement and if possible their general source. It will be seen thus that a great deal of exploration is needed to settle what appears to be a purely theoretical question. Yet the settling of this theoretical question may apply directly to the benefit of agriculture by showing us in some manner from whence the materials composing our soils were obtained.

SEA BEACHES AND SEA BOTTOMS.

Sea Beaches are generally supposed to be confined to the seashore. But researches in other parts of New England have satisfied us that water-worn deposits precisely like the modern beaches may be found at almost any elevation from the ocean level to over two thousand feet above it. As long as we find littoral shells in any deposits in Maine, no one can doubt their oceanic origin. These do not extend above 150 feet higher than the ocean level. The only example of what we regard as an ancient sea beach in Maine of the same type with the gravelly beaches in western New England is near Fort Kent, and we estimate its height above the ocean at 1,500 feet. We expect others will be found in Oxford county.

Extensive deposits are accumulating at the bottoms of existing seas. If, then, we have found ancient sea beaches 2,000 feet above the present ocean level, we may expect to find *sea bottoms* to correspond with them. We conceive that the immense amount of alluvium spread over the low undulating country of northern and eastern Maine is to be referred largely to this class of oceanic deposits. The materials are too much water-worn to be referred simply to the agency of the drift alone. The materials may have been mostly furnished by the drift, and worked over afterwards by the waters of the ocean. Neither the upper beaches nor sea bottoms have yet afforded us any fossils. But the marine clays off the coast have yielded up both littoral and pelagic, or shore and deep-water fossils. Hence they once were sea beaches and sea bottoms, and accordingly some notice of them is appropriate here.

THE MARINE CLAYS.

The fossiliferous marine clays off the coast of Maine early attracted the attention of geologists. They appear to be of the same age with similar deposits along the river St. Lawrence, the valley of Lake Champlain, and more or less along the whole Atlantic coast of the United States. If so, they belong to the Terrace period, as defined above. But we have recently noticed that in Portland these clays underlie a coarse deposit, which has always been referred to the unmodified drift, or the oldest member of the alluvium. Mr. Packard reports a similar position of things in Brunswick, and Dr. Jackson in Bangor. The latter gentleman calls the whole deposit tertiary. Now the fossils ally these clays to the Champlain and Lawrencian clays, which we know by our own observations as well as by the testimony of eminent geologists to overlie the drift or boulder clay. Have we then in Maine a recurrence of the drift agencies, or what might be called a second drift? The facts certainly look like it. We will take no position upon these questions at present, but wait for further explorations.*

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* My father makes the following remarks upon these clays in a letter of December 29: "I had forgotten that I had called the Portland clays Tertiary. never found

These fossiliferous clays occur in multitudes of localities along the whole coast, and frequently far in the interior along the banks of the large rivers. Mr. C. B. Fuller gives us the following list of fossils found at four of these localities in the western part of the State. At Kennebunkport there occur *Pandora trilineata*, *Modiolaria nigra*, *Lyonsia hyalina* *Natica clausa*, *Leda Portlandica*, and several species of *Foraminifera*. At Saco there occur Yoldia *pygmaea?* (Fig. 9.) *Pecten similis?* (Fig. 10,) *Thracia Conradi*, *Pandora trilineata*, *Leda Portlandica*, *Yoldia limatula*, *Leda tenuisulcata*, *Natica clausa* and *Macoma fusca*. At Canal street, in Portland, the following species occur: *Astarte striata*, *A. sulcata*, *A. elliptica*, *A. borealis*, *Pecten Islandicus*, *Nucula antiqua*, *Leda Portlandica*, *Yoldia limatula*, *Saxicava distorta*, *Leda tenuisulcata*, *Mytilus edulis*, *Serripes Groenlandicus*, *Tellina proxima*, *Mya arenaria*, *M. truncata*, *Cyrtodoria siliqua*, *Pholas crispata*, *Margarita cinerea*, *Aporrhias occidentalis*, *Natica clausa*, *N. pusilla*, *Buccinum undatum*, *B. ciliatum*, *B. Donovani*, *Fusus tornatus* and *Balanus crenatus*. At the Westbrook landslide, on Stroudwater river, much larger than the one at Pride's Bridge, the following species occur: *Pecten Islandicus*, *Nucula antiqua*, *Leda Portlandica*, *Yoldia limatula*, *Leda tenuisulcata*, *Mytilus edulis*, *Cardium pinnulatum*, *Astarte sulcata*, *Macoma fusca*, *Mya arenaria*, *M. truncata*, *Saxicava distorta*, *Cryptodon Gouldii*, *Bulla occulta*, *Natica clausa and Buccinum undatum.*

We present figures of a Yoldia and a Pecten found at Saco,

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proof that they lie beneath the drift, as you say you have. I thought them probably the equivalents of the strata at the Light House in Truro, on Cape Cod, which I believe you have seen. I always suspected these to be newer Tertiary, although I could not prove them beneath the drift. It seems to me you will be justified in calling the Portland clays Pliocene Tertiary, if you cannot find drift beneath as well as above them. If you can, they were probably deposited during the drift period in some quiet interval, or more likely in a sheltered spot. Even if the Vermont and Canada clays are above the drift, and contain the same species, it does not prove the Portland species to be newer than Pliocene; for you know that since the Tertiary and even farther back those breaks do not occur in species when a new set were introduced as at earlier periods, and a large number of species lived on from one epoch to another, and I now take the ground that not a few living species do not belong to the Mosaic but to an earlier creation. I know of no way of distinguishing the Pliocene from the Pleistocene Period but by the per cent of living species—the latter having more than three-fourths of the living species, and the former from 50 to 70. But this is a very loose distinction. I called the Brandon deposit Pliocene because it lay immediately beneath the drift; but Lesquereux thinks it a little older. You can put the Portland clays *provisionally* in the same position."

which were thought to be new species. The means were not at hand for their complete identification, and therefore Mr. Fuller presents merely drawings of the shells referring the species with a query to their nearest analogues, the Yoldia *pygmaea?* and *Pecten similis?*

FIG. 9.

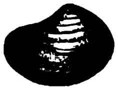
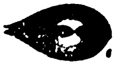
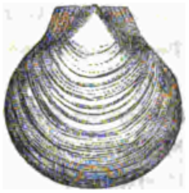


FIG. 9.



Side view. *Yoldia pygmaea?* End view.

FIG. 10.



Pecten similis?

He hopes in the spring to examine them more thoroughly so as to satisfy himself of their exact character. He has made out a list of all the fossils known to occur in these marine clays in Maine, which we hereby present.

Fossils in the Marine Clays.

I have thought best to give in parallel columns the species of animals and plants found fossil in the marine clays in Maine, (mostly in the vicinity of Portland,) and from the St. Lawrence valley. The materials for the latter list are derived from several papers by Dr. Dawson of Montreal, in the Canadian Naturalist. I have followed the nomenclature of Stimpson for the mollusca, and have conformed to the same standard the names of the Lawrencian valley fossils whenever possible. I may have omitted a few of Dawson's specimens, for want of the original materials.

MAINE SPECIES.	ST. LAWRENCE SPECIES.
Vertebrata.	*Vertebrata.*
Vertebræ of whales, two species.	A *Delphinus* (cetacean.)
Specimens of fish in concretion; possibly the same with one of the St. Law. species.	*Mallotus villosus.* *Cyclopterus lumpus.* *Cottus.*
Scales of large fish, such as the Rays.	Remains of a seal.
Teeth of Shark, *Carcharias.*	
Articulata.	*Articulata.*
Cancer irroratus, Say.	†*Balanus crenatus.*
Hyas coarctata, Leach.	*B. Hameri, Ascanius.*
Bernhardus streblonyx, Dana.	*B. porcatus*, Da Costa.
†*Cytheridea Mulleri.*	†*Cytheridea Mulleri.*
Bairdia?	*Spirorbis sinistrorsa.*
A Nereis.	†*S. spirillum.*

†*Spirorbis spirillum*, Lam.
Balanus balanoides, Linn.
†*B. crenatus.*

Mollusca.

Terebratulina septentrionalis, Couth. (Dawson.)
Ostrea borealis, Lam. (Mighels.)
†*Pecten Islandicus*, Ch.
P. similis, ? Laskey.
Nucula antiqua, Migh.
†*Yoldia pygmaea?* Muenst.
†*Leda Portlandica*, Hitch.
Yoldia limatula, Say.
Leda tenuisulcata, Couth. (*Nucula Jacksoni.*)
†**Modiolaria nigra*, Gray. (*M. discors* of Dawson's papers.)
†**Mytilus edulis*, Lin.
Cardium pinnulatum, Con.
†*Serripes Greenlandicus*, Ch.
Cryptodon Gouldii, Phil.
†*Astarte semisulcata*, Moll., (*A. elliptica*, of Dawson's papers.)
†*A. lactea*, Br. and Low., (*A. arctica*, of Dawson's papers.)
†*A. striata*, Leach, (*A. compressa*, Mont.)
Mactra polynyma, Stm.
Tellina proxima, Brown.
†**Macoma fusca*, Say.
**Solen ensis*, Linn.
†**Mya arenaria*, Linn.
†**Mya truncata*, Linn.
Cyrtodaria siliqua, Spengl.
†**Saxicava distorta*, Say.
S. arctica, Linn.
Thracia Conradi, Couth.
Lyonsia hyalina, Con.
Pandora trilineata, Say.
Pholas crispata, Linn.

Serpula vermicularis.

Mollusca.

Rynchonella psittacea, Gm.
†*Pecten Islandicus*, Ch.
Leda minuta, Möll.
†*Leda Portlandica*, Hitch.
†*Yoldia pygmaea*, Muenst.
Crenella glandula, Tott.
†*Modiolaria nigra*, Lin.
†**Mytilus edulis*, Lin.
**Serripes grœnlandicus*, Ch.
Cardium Islandicum, Lin.
†*Astarte semisulcata*, Möll.
†*Astarte lactea*, Br. and Sow.
†*Astarte striata*, Leach.
Astarte Lawrentiana, Lyell.
Tellina calcarea, of Daw. pap'rs.
†**Macoma fusca*, Say.
†**Mya arenaria*, Lin.
†**Mya truncata*, Lin.
†**Saxicava distorta*, Say.
Diaphana debilis, Gould.
Cylichna oryza, Tott.
Amicula Emersonii, Couth.
Lepeta caeca, Moll.
Margarita helicina, O. Fabr.
**Rissoa minuta*, Tott.
**Lacuna neritoidea*, Gould.
**Littorina palliata*, Say.
Scalaria grœnlandica, Perry.
Turritella erosa, Couth.
Menestho alberta, Moll.
Velutina zonata, ? Gould.

Amauropsis helicoides, Johnst.
Lematia groenlandica, Moll.
**Natica heros*, Say.
†*Natica clausa*, Sow.

Bulla occulta, Migh.
Cemoria noachina, Linn.
Margarita cinerea, Couth.
Aporrhias occidentalis, Beck.
Natica pusilla, Say., (*N. Groenlandica.*)
†*N. clausa*, Sow.
Bela pleurotomaria, Couth.
†**Buccinum undatum*, Linn.
†*B. ciliatum*, Faber.
B. Donovani, Gray.
†*Fusus tornatus*, Gould.
**F. decemcostatus*, Say.
Trophon clathratus, Linn.
†*Trichotropis borealis*, Br. & Sow.
†*Lepralia hyalina*, Linn.
Lepralia, (undetermined.)
Lepralia variolosa.
L. Bellii, Dawson.
Tulipora, (undetermined.)
Membranipora, (undetermined.)

Radiata.

†*Echinus granulatus*, Say.
Undetermined Star fish.
Nonionina scapha, Fichtel & Moll.
†*N. crassula*, Wacke.
†*Biloculina ringens*, D'Orb.
Polystomella striatopunctata, F. and M.

Bela turricula, Mont.
Bela harpularia, Couth.
†**Buccinum undatum*, Lin.
†*Buccinum ciliatum*, O. Fabr.
†*Fusus tornatus*, Gould.
Fusus borealis.
Trophon scalariformis, Gould.
†*Tricotropis borealis*, Br. and Sow.
Trichotropis arctica.
Admete viridula, O. Fabr.
Limnaea umbrosa, Say.
L. stagnalis.
Cyclas.
Planorbis.
Hippothoa catenularia, Fleming.
H. divaricata, Lamour.
Tubulipora flabellaris, Fabricius.
†*Lepralia hyalina*, Linn.
L. pertusa, Johnston.
L. quadricornuta, Dawson.

Radiata.

†*Echinus granulatus*, Say.
Ophiocoma, (undetermined.)
Asterocanthion polaris, Moll.
Tethaea Logani, Dawson.
Polystomella umbilicatula, Walker.
†*Nonionina crassula*, Walker.
Polymorphina lactea.
Miliolina seminulum, Linn.
Entosolenia globosa.
E. costata, Williamson.
E. squamosa.
†*Biloculina ringens*, D'Orb.

Plants.

Populus balsamifera, Linn.
Potentilla Norvegica, Linn.
Thuja occidentalis, Linn.
Algae.

The specimens among the mollusca marked with an asterisk are littoral species, or those which live on the shore between high and low water mark. The rest are deep water species. 70 species are enumerated in the list above, as belonging to Maine, and 83 as found in the St. Lawrence valley. 25 species marked with a dagger, are common to both deposits.

It is a curious fact that in the collections of the Canadian Geological Survey, the group of shells obtained by Bell and Richardson in dredging on the north coast of Gaspé, in about 60 fathoms, is almost precisely that of the shells grouped in these clays about Portland. C. B. Fuller.

Dr. Dawson examined some clays from Saco containing the Foraminifera, and remarked as follows respecting the species:

"*Nonionina scapha* Fichtel and Moll. *var. Labradoria* Daw. This is the most common form.

"*N. crassula*, Wacke. One specimen apparently of this species.

"*Biloculina ringens*, D'Orb. One small specimen.

"*Polystomella striatopunctata*, F. and M. (*P. umbilicatula*, Williamson, and my papers on Canadian Post Pleiocene.) A single small specimen.

"This group of Foraminifera is just what we should find in deep soundings in mud from the Gulf of St. Lawrence. All the species occur in the Post Pleiocene of Canada or Labrador.

"In the clay containing the Foraminifera are valves of two *entomostracous crustaceans*. One of them seems to be a young individual of *Cytheridea Mulleri*, found in the Post Pleiocene of Canada. The other very closely resembles *Bairdia contracta*, described by Jones from the Middle Eocene of England; but as this is only one imperfect valve, it would be rash to identify it. No doubt large specimens of these clays, if carefully levigated, would yield many curious microscopic fossils."

These Formanifera are of some use to us in forming our theories. They are mostly so small that a powerful microscope is required to show their characters. They are almost at the lowest end of the animal kingdom. The portions preserved of them are the shells, often divided into delicate chambers. It will be recollected that when soundings were made in the Atlantic Ocean several years ago for the Submarine Telegraph, a deposit of the shells of these animals was found on the bottom several thousand feet from the surface. The beds containing these shells in the clays lie at the bottom of the deposit.

Other localities about Portland are at Munjoy's Hill, Mackay's Island and Bailey's Island. Along the coast the clays occur at Cumberland, North Yarmouth, Brunswick, Thomaston, Cherryfield, Lubec, Perry, etc. They probably form a continuous belt, extending up the rivers to a certain height above the ocean, never more than 200 feet. In the interior the localities are at Gardiner, Hallowell, Augusta, Lewiston, Skowhegan, Clinton Falls and Bangor.

The locality in Westbrook is interesting because the shells are exposed in consequence of a great landslide which took place in May, 1831. An immense amount of clay forming a high bank slid forward, filling up the bed of Presumpscot River, and leaving great chasms in the strata. The lower portion of these clays is a very tenacious, plastic, dark blue clay. The upper beds are more sandy and of a light blue color. The uppermost strata are elevated 70 feet above the ocean. Other localities are near Pride's Bridge, in Westbrook, and on King street, in Portland.

In Gardiner, near the house of Mr. Allen, there is a cliff of this alluvial clay 70 feet above the ocean, containing the following genera: *Macoma*, *Mya*, *Venus*, *Mactra*, *Saxicava*, *Astarte*, *Nucula* and *Balanus*. There are two portions of this clay, as at the slide. The clay has an odor of marsh mud, and traces of sea weeds may be detected in it. The calcareous substance of the shells decomposes more readily than the epidermal animal matter. Many of the fossils in all the localities are in concretions, or clay stones. The fossil forms the nucleus around which molecular forces attract the clayey particles. Probably the siphoniæ said to occur in the clays at Bangor are concretions.

The sand about Augusta belongs to the terraces, but the underlying clay contains marine fossils. The highest stratum of the fossils is 82 feet above the level of the Kennebec River. In Waterville, among shells obtained from a railroad cut, were also found several shark's teeth. An excellent collection of these fossils may be found in the College Cabinet. A fossil starfish and various shells have been found in Lewiston. They were taken from a sandy layer 100 feet above the Androscoggin River and 200 feet above the ocean. They came from 10 feet below the surface. Of these ten feet eight were composed of clay, the rest being sandy.

In Skowhegan and Vassalboro', marine fossils have been found in the digging of wells, both cases being above 150 feet above tide water. In Clinton, there is another locality of marine alluvial fossils 40 or 50 feet above the Kennebec River.

The lower clays of this group at Bangor are very tenacious and adhesive, with the peculiar marine odor of marsh mud, and contain as characteristic shells the *Nucula*, *Saxicava distorta* and *Mya arenaria*. The upper portions of the deposit are more sandy. The clayey strata are of a yellowish cast, containing numerous yellow, soft concretions of clay of a cylindrical shape, and perforated by a long tube. Ferruginous and siliceous sands alternate with the clays. The lower portions of the upper beds contain *Leda Portlandica*, *Mactra* and *Venus*. The upper portions are filled with the concretions. Some of these clays in Bangor dip 10 degrees south-west, and others 15 degrees southerly. The highest of them is about 100 feet above the ocean. Above the clays are found coarse drift deposits.

In the south part of Cherryfield, there are numerous concretions in the clay, containing various fossils for their nuclei. Among others from this locality there have been found fossil fishes and fossil nereids, and an annelid or sea worm. A prolific locality of fossils is at the Plaster Mills, in Lubec. A large canal was dug there in which were found vast numbers of *Pecten Islandicus*, *Saxicava distorta*, *Mya arenaria*, *Mytilus edulis*, *Modiolaria nigra* and *Balani*. Marks of the fossils are found 36 feet above the bottom of the canal. At the height of 26 feet the barnacles are found attached to the rocks. Other localities might be mentioned, but there is nothing specially interesting about them.

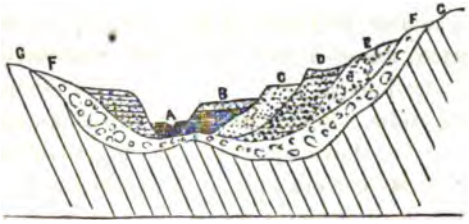
All these fossils except the two new species are the same as the living shells, etc., which are found on our eastern shores. The fossil species are generally larger than the living, and correspond better with the species living in eastern Maine and New Brunswick. This fact shows that the climate must have been colder when the fossil species flourished than it is now.

In the St. Lawrence valley, 67 species of marine invertebrates have been found fossil. All of these, except four or five species belonging to the deep water deposit, are known as living species in the Arctic regions of the Atlantic. About half of them are found in the drift of Great Britain.

TERRACES.

Alluvial terraces are those banks of loose materials, generally unconsolidated, which skirt the sides of the valleys about rivers, ponds and lakes, and rise above one another like the seats of an amphitheatre. Fig. 11 represents an ideal section of a terraced valley, showing the relative position of the unmodified drift, sea beaches and terraces, the whole resting in a basin hollowed out of the older rocks. As we rise from the river, its immediate bank or meadow forms the lowest and latest terrace, A, which may be increasing from year to year. On the margin of the meadow we come to a steep slope whose top, B, forms the second terrace. Very frequently the lower part of this second terrace is composed of clay, and the upper part of sand or fine gravel. Another steep slope carries us to a third terrace, C, which is usually of coarser materials. A fourth terrace, D, is still coarser, and the top less level. D very often runs into moraine terraces. Rising above this, we come to the sea beaches, E. These are generally at a great distance from existing rivers, though upon the general slope facing a stream. Highest of all we come to the coarse unmodified drift, F, and finally to the solid rocks, G.

FIG. 11.



Ideal Section of a Terraced Valley.

This figure illustrates the fact that the drift underlies all the beaches and terraces, although it appears upon the surface at a higher level. The beaches underlie the terraces, and each higher terrace underlies each lower terrace. We see, too, that on the opposite side of the valley we may or may not find terraces. If so they rarely correspond in number and height on both sides.

Lateral terraces are the most common and are those which are parallel to the course of the valley, and often continue for miles along its sides. *Delta* terraces are the accumulations which have been formed at the mouths of streams, whether the junction of a tributary with the main stream or the meeting of the river and lake or ocean. They are seen only where the land has risen since their deposition.

Terraces are not very abundant in Maine, although they are sufficiently common to excite attention. They are often chosen for the sites of villages or of tasteful private dwellings. All the large rivers of the State are lined by them more or less. We have seen them upon the Piscataquis, Saco, Presumpscot, Androscoggin, Kennebec, Penobscot, St. John and St. Francis rivers. They are well developed in Berwick, Brunswick, Waterville, Lewiston, between Bangor and Lincoln on the Penobscot, on the east branch of the same river between Nickatou and No. 4, and upon the St. John river between the mouth of Little Black river and Woodstock, N. B. There are scarcely any terraces upon the St. John above Little Black river, and none on the Alleguash river except near its mouth. We think the terraces on the St. John the most perfectly developed of those in any valley in the State. It is a curious fact that the Acadians have settled on this river no farther up the stream than the terraces extend, and now their emigrants settle upon the Eagle Lakes rather than ascend the river higher.

Beds of Marl.

Two substances are commonly called marl, the calcareous and the siliceous marl. Although these substances greatly resemble each other, their chemical condition shows them to be entirely different. One is nearly pure carbonate of lime, and the other is nearly pure silica. The former is the most valuable.

The calcareous marl is largely composed of the shells of molluscous animals such as snails and clams. It is forming every day at the bottom of ponds from the accumulation of these shells, and perhaps also deriving part of its material from the chemical precipitation of lime held in solution. It is generally a fine white powder. It may be found around the edges and at the bottoms of certain ponds and lakes. When the pond has become filled up so that the water has disappeared, vegetation may accumulate over the marl and conceal it from view. The genera of shells whose remains constitute so large a portion of the marl are *Cypris*, *Lymnaea*, *Valvata*, *Cyclas*, *Planorbis*, etc.

It is essential for the production of marl that the prevailing rock of the region underlying the alluvium should contain a certain per cent. of carbonate of lime, for the animals cannot exist without the means of procuring the substance of their shells. The rocks most favorable seem to be those which contain only a small per cent. of lime; at least it is so where we have made observations on the subject. Hence we need not expect to find marl in a granite region.

Marl beds have as yet been discovered only in small amount in Maine. The beds known to us are all in the northern part of the State. There is a large bed of marl near Ambejijis Lake, north of the west branch of the Penobscot. A long expanse of bog occurs at one end of the lake, and this is underlaid by beautiful white marl of unknown thickness. It lies between this lake and Millinocket, where the marl appears again. We discovered marl in the south part of Fremont, on Elijah D. Robinson's tract. It was at the south end of a bog six miles long, extending into Presque Isle, and it is not unlikely that it may be found beneath the whole of the bog, or at least in several different places in it. The marl where we examined it is mostly pure white, and is full of shells. The following species are very common in it: *Cyclas similis*, Say, a *Lymnaea*, *Pisidium dubium*, Gould, *Planorbis campanulatus*, Say, *P. bicarinatus*, Say, and *P. parvus*, Say. The portion of the marl we saw covered about sixty acres, and would average eight or ten feet deep. The gentleman owning the land north of Mr. Robinson's informed me that the marl appeared on his land also. Marl is found also in Lyndon; and just over the State line, in Canterbury, N. B., we found a fine bed of marl, containing the same shells as in Fremont. A bed of impure marl has been noticed in St. Albans, in Somerset county.

The siliceous marl is composed entirely of the skeletons of microscopic animals and plants. Like the mollusca the animalcules and plants live in the pond, and it is only their imperishable remains that collect on the bottom and form the *polishing powder*. It is surprising that the skeletons of microscopic animals, requiring thousands of millions to form a cubic inch, should yet form deposits of considerable extent. In Bohemia, there is a wide-spread deposit 14 feet thick, every cubic inch of which contains 41,000,000,000 skeletons of a microscopic plant. The smallest animalcule is only the 24,000th part of an inch in length, and a single skeleton weighs only 187 millionth part of a grain; 500 millions of them could live in a drop of water.

In Newfield, there is quite an abundant supply of this siliceous infusoria. Other beds occur beneath peat beds in Limerick. We explored a large bed of it in Chalk Pond, which lies partly in Beddington and partly in No. 22, on the line of Hancock and Washington Counties. About 20 acres are underlaid with it. It is of a beautiful white color. Another bed is in a pond in the south-west part of Calais. Like the calcareous marl, this siliceous infusoria will probably be found in scores of towns as our knowledge of them increases.

Having dwelt thus largely upon the phenomena of Surface Geology, we will now briefly state our theory.

Theory of Surface Geology.

We believe that since the tertiary period the whole of Maine, and with it all the northern part of North America, has been depressed under the ocean at least as high as the top of Mt. Katahdin, or 5,000 feet lower than it is now. Subsequently the continent rose gradually to its present altitude; and while the country was being drained, all the deposits described above were produced. Drift was principally produced by icebergs and glaciers conjoined, both when the continent was sinking and rising again. The forms of modified drift were produced largely by the aid of rivers and currents. All the agencies which operated during these periods are still acting in some portions of the continent. Let us look at the condition of the continent during each period of the alluvium.

The Drift Period. As soon as the continent was submerged, northerly currents brought icebergs over its northern portions, which greatly lowered the temperature. Consequently glaciers would form on mountains comparatively low, reaching to the ocean, as now in the Arctic Zone. The enormous icebergs moving southerly would grate powerfully upon the bottom of the sea, smoothing, scratching and breaking off fragments from the prominent hills and ledges beneath, and leave a stoss and lee side upon them. To account for the transport of materials to higher levels, we may suppose that as the land sunk the stranded ice would be lifted higher and higher along the shores, and finally be urged upon and over mountains, carrying detritus along with it.

When the continent was at its lowest depth, only one or two small islands would remain. During this submergence only icebergs could act upon the rocks. When the mountains appeared again glaciers would renew their wearing action. The water, also, would begin to wear off fragments from rough ledges, and partially sort the materials already collected. It is conceivable that when the continent was partly under water an unusual direction might have been given to certain icebergs which were crowded into narrow valleys, and thus have produced those unusual courses of striæ. During this process, every part of the surface must have been subjected to a thorough washing. Very few animals could have lived during this cold period.

The Beach Period. We suppose this period to commence with the formation of the highest beaches, or when the continent was 2600 feet higher than it is now. The beaches would naturally be produced just as they are now upon the coast, at different levels, as the waters receded. This was the period when the moraine terraces and horsebacks were produced. The former may have been formed by the accumulation of materials around masses of stranded ice. When the ice melted, large hollows would occupy its place. The ice may have remained for a considerable time before it melted, since the sand and gravel adjacent may often act as a natural refrigerator. Indeed, we suppose that some of the ice of the drift period yet remains in certain of these deposits, as in the vicinity of the frozen wells so much talked about.

The Terrace Period. This commences with the existence of the rivers, or currents of water in long estuaries. These currents accumulate materials principally along the sides of valleys, or fill them up entirely. Tides and currents would assist the rivers, and at length the top of the deposits would be at the surface, and no more materials could be added to them. Hence, the same agencies must deposit their next parcels of detritus below the first accumulations, which will presently appear as lateral terraces. The country continuing to rise, a second and a third terrace will appear; and so on as long as the same agencies act. The delta terraces being at the mouths of rivers, are composed of the materials brought down by the current. When the mass has risen above the water, the river continuing to run must cut through it, and thus leave a terrace upon each side of its course.

Thus we see that the simple drainage of a country as it slowly rises out of the water will explain the principal phenomena of terraces. Some authors suppose that the continent arose spasmodically, jerk by jerk, and that the terraces mark the number of paroxysms. But the numbers of terraces do not agree upon different streams, nor upon the different sides of the same stream, even. Nor do the number of terraces upon a river and its tributary correspond in number, as they ought were the elevations paroxysmal.

We have sometimes fancied that a large part of Maine had not yet completed its terrace period, since the terraces are scarce and the lakes numerous. For when the country was partially drained, it is obvious that the rivers would be a series of lakes. Any one who examines the new State map of Maine will be struck at once by the strings of lakes represented upon it, and the geologist who has travelled among them notices the absence of terraces. As soon as the lakes are drained the terraces will appear. Sometimes the lakes are drained suddenly by the bursting of a barrier, as was the case with Little Sebago Pond in Windham and Gray, last May. The natural size of the lake was largely increased by a wooden dam. The dam having given way, the pressure of the water made an immense rent in the gravel barrier, and then rushed out in a mighty torrent, carrying devastation in its path. Sixteen bridges were carried away by it, and many fertile meadows were covered by sand. The freshet illustrated the formation of terraces in two ways. First there were small terraces left on the sides of the lake, which had been gradually accumulating for years around its edges. Second, the materials scattered over the low lands of the course of the outlet assumed the terrace form. Other lakes in the State are confined by gravel barriers, and it would not be strange at any day to hear of their bursting like Sebago. Such a case is Alamoosook pond in Orland, and also Great Sebago lake. If the latter should break loose the damage done would be very great, and might result in the loss of life.

During the terrace period life was abundant on the continent, both terrestrial and marine. To this period we refer the marine clays of the coast, and the fossil elephants and horses of the interior; though both classes lived into the historic period, and are not all extinct now.

The Historic Period.

We are now brought to the period when the country had attained essentially its present altitude. All the agencies that produced drift are still in operation in different parts of the continent, hence both modified and unmodified deposits of drift are now being produced. In other words, the agencies producing these two classes of deposits have run parallel to each other from the very first.

Man has existed on the earth a comparatively short time of the alluvial period. Recent researches in Europe show that the extinct mammals of the alluvium were contemporary with the earliest generations of man, probably having become extinct about the time of the flood.

We have in Maine some relics of the Indians which have excited a great deal of attention among the curious, and by eminent geologists have been referred to oceanic agency for their origin. We refer to the piles of oyster shells, etc., in Newcastle, Damariscotta, Trenton and numerous other localities on the coast. The dimensions of these deposits have been very much exaggerated. Without a careful examination, one would think that a bank ten feet high was entirely composed of these shells, while the deposit may be only a couple of feet thick on top of the bank, and its materials be scattered down the sides of the bank. We are fortunate to be able to present a judicious account of these remains in Newcastle from the pen of Professor Chadbourne, of Bowdoin College, taken from the publications of the Maine Historical Society. His statements are convincing, and his positions impregnable.

Williams College, May 18, 1859.

John McKeen, Esq.—*Dear Sir:* On the twentieth of April I visited the beds of oyster shells at Damariscotta, according to your suggestions. I did not have time to visit all the beds in that region, but I believe I examined those that are considered the most important. I have no doubt that the shells examined by me were deposited by men. This I infer—

1st. From the position of the piles of shells.

2d. From the deposit beneath them.

3d. From the arrangement of the shells in the piles.

4th. From the frequent occurrence of charcoal mixed with the shells, even to the bottom.

5th. From the fact that fires have evidently been built among them, near the bottom, turning a portion of them to lime, which is mingled with charcoal.

6th. From the mixture of other animal remains,—as common clams, (*Mya arenaria,*) thick shelled clams, (*Venus mercenaria,*) fragments of birds' bones, of beavers' bones—with their teeth, and sturgeons' plates.

1st. The first thing that strikes the observer is the occurrence of the shells in small piles, ten or fifteen feet in diameter, and apparently two or three feet deep. They seem to rest upon the surface, and to have no soil upon them except that formed by their decomposition and the other substances that would naturally collect from fall of leaves, decay of plants, and movement of dust from year to year. We did not have the time to dig through any of these. I give only the impression that I gained by examining them as they now are,—and that is, that they were deposited upon the land in its present position.

2d. Where the river has washed away the bank, we have a fine opportunity of examining the deposit beneath the shells, and also their line of juncture with that deposit. We find that deposit made up of sand, gravel, and boulders mingled—a diluvial deposit like all the land in the vicinity beyond the shells; and the line of juncture gives the appearance of shells thrown upon dry ground. There was no appearance of wearing, or mingling of the sand with shells, and in one place, where a boulder was upon the surface of the sand, they seemed to rest against it in a way that precluded, in my mind, the action of water.

3d. Wherever we found a deep section of shells so lately made that the surface had not decomposed, the *open* appearance of the shells was marked. They were not mingled with fragments of bone or broken shells, or with sand,—presenting, in this respect, an entirely different appearance from the great deposit of oyster shells by water at the mouth of the St. Mary's River, Georgia, which I had an opportunity of carefully observing two years ago.

4th. In these places, in deep sections, we found fragments of charcoal mingled with the shells under conditions that showed conclusively that they could have been deposited there only as the shells were deposited. The coal left with you was taken out in a deep section very near the bottom. So common did we find the coal that I feel confident it can be found there by any careful observer.

5th. In one section, a dark line was seen near the bottom of the deposit. Perhaps a foot from the bottom, along that dark line, fragments of charcoal were found, and the shells for a few inches underneath were decomposed, as though they had been acted upon by fire; and in this same place were found most of the fragments of bones left in your possession. I have no doubt a fire was built upon the shells when the bed was about one foot in thickness.

6th. The fragments of bones left in your possession are to be submitted to any person desirous of examining them. I consider the jaw and teeth of the rodent animal to be those of a beaver. There is certainly one fragment of a bird bone. And I would call especial attention to the manner in which these bones are broken, as though done with some instrument. I can think of no other means by which they could be broken into such fragments.

The large mass of shells might be used as an argument in favor of deposition by water, but if careful examination proves that they were deposited by men, then the great mass only proves the great number of men or the great length of time during which these shells were accumulating. No man can pronounce an intelligent opinion upon them, without an examination. From what I had heard, I expected to find that they were deposited by water. There may be beds of shells in that region deposited in this way, but I am fully convinced that those examined by me were deposited by men. I would write more at length, but I am very much pressed by my duties. Some future day, I should be glad to explore those beds more fully.

Very truly yours,

P. A. CHADBOURNE.

We take the following from "Sewall's Ancient Dominions," page 21, in relation to similar deposits upon Sawyer's island:—

"The entire deposits are estimated to cover an area of some ten acres of soil, consisting of the debris of the bony structure of man, beast, fish and fowl, in every stage of decomposition, from the dusty outline of crumbling earth-crusted bones, to perfect skulls, joints and teeth, in good preservation. The remains of the "mya edulis," or common clam, constitute the great deposit here; and the entire superincumbent mass of animal matter has generally reached a stage of decay, in which it has become a very productive dark colored soil.

"The Slopes of Sawyer's Island, broken to the plow some thirty years ago for the first time, interspersed with the layers of the common clam, (which here is the prevailing deposit), disclosed patches of oyster shells of large size in good state of preservation. Antlers of the red deer, bones of the cod, skulls of the canine, and teeth of large graminiferous animals were found, mingled with the teeth, ball and socket, skull bones and sections of the vertebral column of the human frame. Indeed, it would appear that the ashes of the human dead were everywhere strewn throughout the mass of decomposing superficies, which the hoe and the plowshare everywhere discover."

Some excavations described by Mr. Sewall are very singular—very much resembling the pot-holes in the rock, worn by the rush and fall of water. With the suspicion that they may have been formed by natural agencies, we quote his account of them:

"A narrow cove penetrates Sawyer's Island from the north, dividing it nearly through to its southern slopes, across the mouth of which lies a ruined wall covered with long-grown seaweed. Near the head of this cove, an island-shaped, soil-clad rock strikes off in a lateral spur, from the eastern shore side. The rock is a very coarse granite. Sunk into the bed of this solid rock, with the perfect circles and shape of an iron pot, near three feet deep by two feet five inches in diameter, are the remains of several perfectly shaped and truly cut perforations, just at the line of high water mark. The outlines of two similarly shaped openings are traced immediately above the more perfectly excavated ones at the tidal margin; and the whole mass of this rocky bed seems to be affected by a process of chemical decomposition, like to calorific agency of heated water, so that on its lower side, this rock-embedded stone-carved kettle has partially sloughed off.

"On the opposite western shores of the Sheepscot [river], at an elevation of sixty feet above the sea, two like excavations are said to be found, near the mouth of Robinhood's cove, but of larger capacity, (one of eight feet deep by four feet in diameter,) and the other six feet deep by three feet in diameter), and evidently a work of art."

Two species of oysters occur in the Newcastle beds, *Ostrea borealis*, Lam., and the *O. Virginiana*, Lister. The latter is the longer shell, and has never been found living, to our knowledge, upon the coast of Maine, although what is considered the same species occurs on Prince Edward's Island. The *O. borealis* is very rare upon the Maine coast. A few specimens of the living animals have been found in Sheepscot river, not a great distance from the Indian beds, yet with some peculiarities of shape. It is said that this oyster was formerly very common in the vicinity of its present habitat, but that the introduction of saw-mills on the river filled the water with sawdust and the oysters were thus mostly exterminated. It is also found at the mouth of Harriseeket river. Another shell which is found in the shell-beds, the *Venus mercenaria*, or the quahog, is very scarce on the coast. Dr. Gould had not heard of its existence north of Cape Ann in Massachusetts, when he wrote on the mollusca of Massachusetts. Mr. Fuller states that it is extinct in Casco Bay, but that a very few specimens have been found beyond Harpswell. Capt. Thompson, of Trenton, told us about a "New York clam" generally supposed to be extinct about Mount Desert Island, but which he had occasionally found in the stomachs of water fowl, and rarely upon the shore after a very heavy storm. This we suppose to be the quahog; at least some nearly extinct species.

The conclusion to be derived from all these statements is this: The Indians obtained vast quantities of the two species of oyster and the quahog off the coast of Maine for a long time. It is not reasonable that they should have transported shell-fish from Massachusetts for their support when other means of sustenance were at their command. It is very evident that these species are now nearly extinct, and that since the disappearance of the Indians; yet it was not caused by the works of the whites, as there are many places where these species formerly flourished in great abundance, where no saw-mills or other work of art could disturb these animals. If, then, these shells have become extinct naturally, have we not before us evidence to confirm the conclusion to which the discussions respecting the duration of man upon the earth have arrived? In Europe flint implements of man's handiwork occur with the remains of extinct animals. The hurried inference of the moment was, that as these animals became extinct more than 6,000 years ago in a past period, therefore, man had lived upon the earth longer than 6,000 years. The more reasonable conclusion is that these animals did not become extinct for some time after man's appearance, and that perhaps he was the means of their extermination. This conclusion is confirmed by the association of these nearly extinct shells with human remains in these beds off our coast. Animals became extinct in certain localities long after the introduction of man. It is a curious coincidence that as extinct forms of human implements are associated with the extinct mammals in Europe, so in Maine the remains of a nearly extinct race of men are associated with nearly extinct animals.

This subject is certainly one of great interest, and is worthy of a careful and thorough investigation.

Numerous piles of these Indian remains are found in a great many islands in Casco Bay. The shells found among them, besides the oyster are the *Mya arenaria*, or the long clam, *Natica heros*, *Crepidula fornicata*, *Solen ensis*, or the razor shell, and *Venus mercenaria*, the quahog. About Mount Desert these piles are also common. There are no large deposits of the shells, but they are disposed in small piles all along the coast. One of the piles in Trenton is six feet thick. The clam-shells predominate in it. These deposits are so numerous that they deserve a separate color upon a map of the surface geology of the State.

ECONOMICAL GEOLOGY.

Economical Geology is an account of rocks with reference to their pecuniary value, or immediate application to the wants of society. These may be included under the three general heads of mining, engineering and architecture, and agriculture. We shall treat of the substances which are mined, and treat exceedingly briefly of the relations of geology to engineering and agriculture. We regret that the time spent in unfolding the scientific part of the report prevents us from doing justice to this department.

Mining relates to the means employed for the extraction of ores from their native beds and veins. We cannot have time to speak of these methods nor of their occurrence any farther than may be noticed incidentally. The metals that may be obtained in Maine are iron, lead, zinc, copper, tin, manganese, arsenic and gold. Ores of iron are mined from which alum and copperas may be manufactured.

Iron Ores.

Iron is the most useful of all metals. Owing to the difficulty and expense of manufacturing it, when compared with other states and countries, the beds of these ores in Maine which might have been worked have as yet scarcely been touched. There are very few places in the whole state where pig iron is or has been manufactured from the native ore.

Dr. Jackson discovered a fine bed of red hematite in Aroostook county in No. 13, R. 4, or what is now called Waite Plantation, which he thought to be of immense value. Not having visited the locality we cannot speak with certainty about the value, but will quote from his report. He was very sanguine that the ore could be successfully worked:—"Its outcroppings may be seen in two different places upon the side and on the summit of the hill. The lower bed runs north 9 degrees east, and dips 85 degrees eastwardly. The upper bed runs north 5 degrees east, and dips also to the eastward. This ore occurs in calciferous slate charged with manganese, its colors being red, green and black. The strata run north 16 degrees west. In order to ascertain the extent of this ore, I caused the soil to be removed in several places, and on finding the boundaries of the principal bed it was measured and found to be 36 feet wide. The soil overlaying it was covered with an abundance of red sorrel, which served to indicate the position of the ore, and by digging along its margin we always found the hematite below. The soil is very thin and composed entirely of disintegrated ore. I measured the limits of the bed as far as I was able to expose it, and found its length to be 450 feet. It continues into the forest, and is probably connected with the great bed of iron ore which I discovered last year upon the Meduxnikeag, at Woodstock. The hill at Currier's is more than 100 feet above the river's level, so that a mine may be easily wrought and drained. Let us now calculate from the measurements which we have made, the quantity of iron ore which may here be obtained.

"Thus the bed is 450 feet long, 36 feet wide, and can be drained easily to the depth of 100 feet. 430×36×100=1,620,000 cubic feet of ore, each cubic foot weighing 240 lbs. 1,620,000×240=388,800,000 lbs. of ore, or 97,200 tons of metallic iron.

"In 100 grains the ore contains as follows:—

Water, - - - - -	6.00
Silica, - - - - - -	8.80
Peroxide of iron, - - - -	76.80
Ox. manganese, - - - - -	8.20
	99.80

"76.8 of peroxide of iron contain 53 of pure iron, hence we may say that the ore will yield 50 per cent. of bar iron or 60 per cent. of cast iron, for about 7 per cent. of carbon enters into the composition. Ten miles above this place, on the margin of the Aroostook River, occur the materials required for the erection of an iron furnace. Limestone suitable for a flux abounds in the immediate vicinity, and on the Tobique Stream, opposite to the mouth of the Aroostook, is an abundance of new red sandstone suitable for the lining of the furnace and for hearthstones, while charcoal may be had in any quantity for the mere labor of cutting and burning the wood. By means of charcoal the finest varieties of iron may be manufactured, like that brought from Sweden, and capable, like that metal, of forming the best cast steel."

A similar bed of mammoth proportions is situated just over the province line in Woodstock, N. B. But the same bed extends through two or three townships in Maine, and we examined it at Hodgdon. The most favorable portion, perhaps, of the bed was not examined by us. We saw it in the north-west corner of the town, running north sixty-five degrees west, on Greenleaf Bean's land. The ore is occasionally magnetic. The bed may be traced to Daniel Buck's house in Linneus. The bed as we saw it is three rods wide, in perpendicular strata. It is in a favorable location for mining. The quality of the ore is the same as that from Waite, judging from hand specimens ; and if that proves to be of as great value as represented, this will be still more valuable on account of its proximity to the market. The same facilities for fluxes and charcoal are found here. It is remarkable that this ore should be so largely developed in this county.

Another bed of iron ore of a different variety—the bog ore—is found in great amount in the next town, New Limerick. It shows itself at the base of a hill at Drew's sawmill. The origin of the ore is from a white limestone containing many beds of beautiful iron pyrites, which in itself is a useless ore for obtaining iron. Pyrites is composed of sulphur and iron. The two elements oxidize, and the sulphur escapes, leaving the oxide of iron as bog ore. The strike of the limestone would carry it along under the hill. It was said that this bog ore was found at the base of this hill for miles. If so it would form an invaluable repository of iron, since it is more than ten feet thick, and can be dug up almost as easily as earth. It would be far more valuable than the Waite deposit.

At the "Katahdin Iron Works" a large amount of iron has been manufactured from the bog ore, which is inexhaustible in quantity. Mr. Houghton has explored this region, and we beg leave to refer to his report in Part II. for the particulars.

In Newfield iron has been manufactured from the same bog ore. It seems to occur there in great abundance. The ore yields from 40 to 45 per cent. of excellent cast iron. The ore is about ten feet thick, and of unknown extent. Extensive deposits of bog ore, often of sufficient extent for the manufacture of iron, occur in Shapleigh, Argyle, Clinton, Williamsburg, Bluehill, Lebanon and Union, and small ones in Canton, Paris, Saco, Jewell's Island and Thomaston. Sometimes a furnace might be sustained by ores brought from several localities near one another. Or bog ore in the vicinity of magnetic ores may be used in connection with the latter to advantage. Add the following localities to the above of bog ore: Bristol, Bucksport, Dixfield, Dover, Farmington, Greenwood, Jay, Liberty, Rumford and Winslow.

A large vein of magnetic iron ore is found on Marshall's island in granite. The vein averages three feet in width, and forty feet in length. It contains 70 per cent. of metallic iron. Other veins of the same ore occur upon the island, and others occur on Mount Desert Island, besides another ore on Black's Island, so that there is a large amount of the ore in the vicinity. Another region of magnetic ores of iron is in Buckfield, in two different localities, where there is enough of the ore to supply a forge easily.

These are the most important beds and veins of iron known to exist in the State. We have examined a large number of localities where it was thought iron might exist in quantity, but have discovered only small amounts. To save time, we pass by the notice of these places. The facts given above show that Maine contains the materials for the manufacture of an abundance of iron. It needs capital, perseverance, patience and economy in expenditure to manufacture iron, especially as its value fluctuates so much in the market. The direction political matters seem to be taking in our country argue that in the future we may be obliged to manufacture our iron, or shall have increased opportunities for so doing. A great obstacle to its production heretofore, has been the great wages demanded by the workmen for their labor, when compared with the wages in other countries. We sometimes feel a pride in the fact that the laboring masses of our country demand a higher price than those abroad, because it shows a greater degree of general information and ability. We had rather live forever on foreign iron, than have our laboring classes reduced to the low level of the corresponding classes abroad. But improvements in machinery in future may reduce the number of workmen needed, and thus competition be rendered easier.

Lead ores.

Lead ores are in great demand at the present juncture, and it is fortunate that there is one good mine at least of it in Maine, viz., at Lubec. Localities of the ore in small quantities are abundant, as may be seen by examining Mr. Houghton's catalogue of minerals in the State, the galena being the common ore of lead there mentioned.

In Parsonsfield, at Kezar falls, a vein of lead and zinc ore has been found, which is valuable as indicating the existence of the ore in the vicinity. It may be that more valuable veins will be found in the vicinity. The vein is only two inches wide, and is included in a gaugue of quartz in granite. The vein runs north 10 degrees east, and shows itself again in Denmark. An attempt was made once to work this vein, but the results were unpromising.

We spent some time in examining the Lubec lead mines this summer, and find matters there to be exceedingly interesting. The company has recently been reorganized and are working vigorously. A crushing mill was then in process of construction which has since been completed and now, we understand, works finely. We found that Dr. N. S. Manross of Bristol, Conn., had made a most thorough examination of the property, and that the most we could do was to satisfy ourself of the correctness of his observations. This we have done, and present herewith extracts from his report, omitting many details relating to the means required for the working of the mines. We have collected specimens from all the sixteen veins referred to, which are on exhibition in the State Cabinet. We were much indebted to the kindness of the superintendent of the mines.

Extracts from N. S. Manross' Report on the Lubec Lead Mine to the Proprietors, June 30, 1860.

"The property is accessible from Eastport, the nearest steamboat landing, by two routes, viz: by ferry, (sail boat,) three miles to Lubec, and thence by carriage road seven miles, or else direct by boat from Eastport to the mine, a distance of nine miles. It covers a high bluff or promontory, between South Bay and Bassett's Creek, two excellent sheltered harbors, having sufficient water at high tide for ships of almost any size. A county road passes along the western boundary of the tract, giving convenient access from the landward side. The tract contains about one hundred and four acres, and has a very crooked shore line, measuring a little more than one mile and a half. Except a portion of the northern side the shore is everywhere unusually steep, rising abruptly nearly one hundred feet. This is particularly the case just where the principal veins occur, thus affording uncommon facilities for working them without artificial drainage.

"The rocks which appear upon the tract are argillaceous and calcareous slates, and greenstone, the latter not so much in the form of intruded dikes as in that of altered slaty beds. In some parts, as near the summit of the property, the greenstone becomes crystalline and porphyritic. The more slaty beds appear mostly on the shore, in the vicinity of the larger veins, by which they are intersected without regard to their stratification. At one point in the calcareous strata a few impressions of shells are found, though not sufficiently distinct to fix the exact age of the formation. But whatever its age may be, the formation is quite extensive, appearing at Quoddy Head and Campo Bello, and stretching away many miles to the westward of Lubec. Veins carrying lead occur at very many points over this entire distance. I visited one such place. where three considerable veins of metal appear some three miles distant from the company's tract. The occurrence of lead therefore at the latter place is not exceptional or singular, although the size and number of the veins, as well as their richness, is far greater than at any other point yet discovered. In fact, the company's property is not only most admirably situated for convenient working, but it appears to be the centre and richest portion of an extensive and promising lead bearing region."

Veins upon the Property.

"Commencing on the west and passing along the shore, sixteen veins appear at places indicated by red lines and numbers on the map, [and by large figures painted upon the rocks at their several localities.] All of them show veinstone wholly different from the enclosing rock, have courses nearly at right angles to the strata, contain considerable ore, and, in short, exhibit all the characteristics of true mineral veins.

"Vein No. 1 is large and rich, forming a wall fifty-seven feet long upon the shore. At the outer end it slopes down under the bay, showing large masses of ore as far as left bare at low tide. On the west it enters the steep side hill, and extends apparently quite across the property, a distance of 1500 feet. It has a course by compass south 87 degrees west. Its dip is south about 75 degrees. Its average width cannot be less than four or five feet, while on the shore it bulges out to twice that size. The vein appears about fifty feet from the water, on the cliff, and at still another point somewhat more than half way across the property, where it makes another bulge, and shows rich strings of ore.

The metal bearing portion of this vein was estimated at one foot in thickness. Of this at least three inches is solid ore, containing lead and zinc in about equal bulk. The average height of 'backs' upon this vein is from ninety to one hundred feet. At the bulge spoken of it measures one hundred and ten feet above tide.

"But little work has been done on any part of this promising vein. A drift of about a fathom in length, at the shore, and a few scattered blasts comprise the whole; and yet there are many tons of metal in sight, with every appearance of great richness, within the hill as well as under water. It ought to be fully explored, first by driving upon it, and afterwards by a shaft within or at the entrance of the drift.

"No. 2 is a small but well defined vein, carrying some ore and running nearly parallel with No. 1. Its width is six inches.

"No. 3 is about three inches wide, and carries three fourths of an inch of metal.

"No. 4 includes several small seams scattered over a breadth of three yards, and estimated at eight inches in the aggregate, of which two inches is mixed ore of lead and zinc.'

"No. 5 is a fine, strong vein, standing up like a wall upon the shore. It forms a facing to the cliff for a distance of eighty-seven feet. Through half this space it shows sheets of ore averaging two to three inches thick and twelve feet high—the proportion of zinc to lead being somewhat larger in this than in the other veins.

"No. 6 is a small vein, averaging two inches wide and carrying about one half an inch of metal.

"No. 7 is a rich and promising vein, having a productive width of eighteen inches. It has been opened more extensively than any of the other veins except No. 8, a level having been driven upon, or rather beside it, leaving the vein mostly standing, and penetrating one hundred and thirty-seven feet into the hill. Before reaching the end of this drift the vein divides and the branches taper down to a breadth of two inches. Upon the top of the cliff, nearly one hundred feet above, the same appearances of branching occur, but the branches seem to regain their width at no great distance beyond, and are also rich in metal. There is little doubt that the vein may be recovered in the drift by proper exploration. It has not been opened in depth below the level of high tide. So far it proved wide and rich, and doubtless extends far out under the water.

"That portion of the vein now standing contains at least six inches of solid ore, the greater part lead, the rest zinc.

"This vein is one of the most important upon the whole property. If it regains its size and richness within the hill, it may be most conveniently pursued, having nowhere less than one hundred feet of 'backs' above high tide. If not productive in this direction it should be followed downward and outward from the shore, where it traverses the same slaty rocks which enclose the rich portion of the vein now standing in the drift. It is not unlikely that all the veins may be found more productive in these slaty beds than in the more compact greenstone.

"No. 8 (shaft vein). This is again a large and rich vein, running as nearly as can be ascertained parallel with No. 7, and distant from it one hundred and thirty-two feet. It is somewhat more than one foot thick, and well filled with metal—chiefly lead. A drift has been carried in upon it to where it was cut off by a cross seam and 'heave.' Near this heave, the vein is said to have yielded ore about one foot thick. The stoping in the drift has been carried up some twenty feet towards the surface, where the vein still shows three or four inches of solid ore. Above ground, on the cliff, the vein has the same appearance of being divided as No. 7. Farther up on the top of the hill, a wide and somewhat curved vein appears for many rods above ground, carrying considerable metal, and seeming to be a continuation of the right hand branch of No. 8.

"The direction of the heave might probably be ascertained by removing the loose materials which cover the vein upon the side of the cliff directly over the end of the drift. This point is a very desirable one to be ascertained, as the vein presents the same advantages of size, richness, height of backs, and facility of working by the drift as No. 7. A shaft (seven and a half by nine feet) has been sunk upon the back of the vein to the depth of ninety feet below high tide. Its position is shown upon the map. From the bottom of this shaft the vein was reached by driving eleven feet. A drift was then carried along by the vein out under the bay to a distance stated by Mr. Blight (the superintendent at the time), to be one hundred and seventy feet. The vein is said to look well at this depth, but was not taken down for want of machinery to separate the ore. During the working of that drift the water was kept out solely by a hand windlass, showing that the leakage from above was very slight. Indeed, the bottom of the bay is so completely 'puddled' by a covering of tough clay, that the veins might be taken out from below very near to the surface of the rock, without serious inconvenience from water. * * * *

"No. 9 vein is the largest upon the property, and in many respects the most promising. It has a course by compass north 31 degrees west, so that all the larger veins upon the shore, viz., Nos. 1, 5, 7 and 8, must intersect it under the bay, while inland there are numerous other veins which will be likely to cross it in the hill. These junctions will probably prove rich in metal. It is along the course of this vein, therefore, that the richest deposits of ore may be looked for. The vein is exposed for a length of one hundred feet at the shore, where it has a breadth of fifteen to twenty feet, and carries metal diffused through nine feet of this width. It also appears at three places on the hill, all ranging with each other and with the portion on the shore. There can be therefore little doubt of the continuity of this vein from the shore to the farthest point where it is visible, (by the fence,) a distance of five hundred feet. At that distance it has a width of eight feet, and shows a string of metal one inch thick. There is no appearance of the vein terminating there, but it disappears under the soil of a meadow, and might doubtless be found further on by sinking cross pits along its course.

"The most remarkable peculiarity of this great vein, aside from its size, is that the zinc blende, so common in the other veins, is entirely wanting in this. The ore is rather a fine grained galena, occurring in strings and masses, as well as in sheets of several inches thickness and two or three yards length and height. The excavation already made measures twenty-three feet long, sixteen feet high at the beginning, and twenty-seven feet at the end, by nine feet average width. It has therefore yielded about 4,450 cubic feet of rock. Of this, by a rough estimate, 1,237 cubic feet have been reserved for crushing. As nearly as could be ascertained by running samples, this portion contains about ten per cent. of ore. Taking the specific gravity of the rock at two and a half, and that of the ore at seven and a half, the rock would yield 16 74-100 lbs. of ore to the cubic foot. The pile contains therefore about ten and a quarter tons of ore, which, being wholly free from zinc, needs only the simple operations of crushing and washing to fit it for the market.

"The quantity given above would correspond to a shaft of ore the height and length of the excavation, and a little more than one inch in thickness. But as the ore occurred mostly near the inner and lower parts of the cut, the actual thickness in the metallic portion of this vein is several times greater than that average. It may be safely estimated that large portions of the vein, such as would be taken down in stoping, would contain from six to eight inches of ore, giving from four to five tons per square fathom. The section will show how much of the vein is accessible above high water mark. When this has been worked out, or before, a shaft should be sunk upon the vein near the mouth of the present level, and from it the work carried on both ways. Out under the water, the junctions of Nos. 7 and 8 may be looked for, the first about one hundred and twenty, the other two hundred and fifty feet from the shore. These junctions, as before stated, may prove very rich in ore. The first of them may be reached by the shaft now sunk on No. 8, although the present level at the bottom of the shaft is probably too near the surface of the rock to be safely carried further. But if that shaft be deepened, as recommended, another drift may be carried from the bottom (one hundred and twenty feet deep) along the vein, and the deposit at the junction made available without waiting till a shaft be needed on the great vein.

"The gangue of this vein consists of quartz and calcareous spar, the latter often containing large cavities partly filled with earthy oxide of manganese, a structure regarded as highly favorable to the richness of the vein. So far as tested the vein stone has not proved difficult of excavation. It is thought the level may be carried in at the rate of from one to one and a half fathoms per week. * * * *

"No. 10 is a small vein consisting wholly of calc spar, carrying but little lead. It has a course, as near as can be seen, parallel with No. 9.

"No. 11 is a rather large vein, chiefly of quartz, exposed only below high tide. Its width is about three feet. It carries some lead and has a course parallel with Nos. 7 and 8, of one of which veins it may prove to be a continuation on the other side of the great vein.

"No. 12 is a vein of calc spar, with considerable lead, but cutting only across a small point of rock and having no course on shore.

"No. 13 consists of several strings, making four or five inches in all.

"No. 14 is a vein five inches wide, carrying ore one inch thick

"No. 15 is a vein six inches thick, metal not very abundant.

"No. 16 is six inches wide, and rather rich in metal. This vein has a more promising look than most of the others on this part of the shore. Its course would carry it lengthwise through the property, while some traces of lead along its strike indicate that it is quite extensive. It would deserve immediate attention, if the tract were less rich in larger veins.

"The ores of all the veins, except the great vein, (No. 9,) which is free from zinc, present a similar appearance, consisting of a rather fine grained galena, mixed with more or less of zinc blende. In some of the veins, as No. 8, fair specimens of yellow copper ore are found. But this is not abundant nor likely to become so. In several careful assays of the ores from Nos. 1, 5, 7, 8, and 9, I could not obtain more than one and a half ounces of silver per ton of ore. The samples were taken near the surface, where they had long been exposed to sea water, and from the well known action of salt upon silver and its compounds, it is quite likely that much of the silver originally contained in the ore, has been removed. The ores farther in the hill may therefore be expected to contain a somewhat larger quantity of the precious metal, although it is not probable that this will ever be enough to pay for separating.

"The zinc, if separated as proposed, may pay its own expenses, or perhaps something more. But what the company own is essentially a lead mine, and as such it must "stand or fall."

"The points above enumerated on the shore, together with the very numerous places where lead is found upon the top of the hill, are sufficient to show that the whole property is intersected by a net work of metallic veins. A level driven in almost any direction, could not fail to open rich deposits within a moderate distance. But the exposure of the larger veins, Nos. 1, 5, 7, 8, and 9, upon the shore, affords the best possible opportunity of exploring the whole tract by drifting on them, without the expense and uncertainty of driving at random through barren rock. It is hardly possible to imagine a situation more favorable for economical and successful working, than this. Either one of the five large veins, above discovered, would fully justify the outlay necessary for its development; while taken together they form a basis for profitable mining, such as is seldom met with. I cannot too strongly urge upon the company the propriety of pushing on their enterprise with the greatest energy and confidence during the present favorable season, believing fully that the mine may be brought into full paying condition before the setting in of winter."

In Dexter, there is a gangue of quartz containing galena, blende, iron and copper pyrites. The vein varies from 8 to 24 inches in thickness, of which the galena is from one to three inches in width. It runs north 70 degrees west, and dips 45 degrees south-westerly. A similar vein in Corinna is six miles long.

Zinc and Copper.

It is doubtful whether the ores of zinc and copper, so far as explored, are sufficiently abundant in Maine to warrant attempts to work the veins. They are common with the lead at Lubec, but do not appear to be worth extracting, as the lead is of so much more value. These minerals are both found with the lead ore in Parsonsfield. We visited in September a vein of copper and iron pyrites on Campo Bello Island. The vein is two or three feet wide and has been explored a short distance. The ores are contained in trap. At West Quoddy Head, there is a vein containing ores of lead and copper. In Cutler, there are several very important cross cut veins containing lead, copper and zinc, which promise favorably. We have no doubt that some of them will be worked profitably. The south-east part of Washington county is a true metalliferous region. The principal veins may be at Lubec, and the numerous smaller veins scattered over the whole region be only their *leaders*, and of little account; but we suspect that the most important veins have not yet been discovered. There should be a large map made of this region with marks to indicate the position of every vein. The veins are largely cross cuts; that is, perpendicular veins crossing the strata at right angles. These are universally the most favorable sort of metallic veins.

We must not neglect to mention the possibility of finding in Maine the continuation of the very rich copper ores of Canada and New Brunswick. In Canada East, particularly in Acton, there are veins of copper ore which are exceedingly productive. The formation in which they are found runs north-easterly, and there is a possibility that they may run into the north-west part of Maine. We feel like saying that there is a probability that this copper ore will be found in Maine, because in our exploration of the St. John river we found the talcose schist, the rock containing the copper belt, where its existence had never before been suspected. We refer to our map in Part II to show how great an area is known to be occupied by this rock on the upper St. John. The facts are such as to warrant the government in prosecuting the survey of that part of the State, even if merely an examination for copper ore is made. We were able to spend but three days in the exploration of a very small part of this talcose region the past summer, and we were the pioneers of scientific exploration there.

Perhaps a more certain field for the discovery of copper is that part of our territory which lies to the south-west of Woodstock, N. B. A mine of copper has recently been opened in that town, and the specimens of ore which we have seen from there are very rich. This is very near our boundary line, and the course of the strata points to the townships south of Houlton, which are very sparsely settled. We should recommend an examination first of the Woodstock mine, and then an expedition through the fields and forests without regard to hills, valleys or roads, that the extent of the metallic rocks south-westerly may be ascertained. We consider this district as more promising than that of the upper St. John river. Since writing the above, we have heard of the discovery of native copper near Carroll, which must belong to the Woodstock belt.

Tin.

No ore could be worked to greater profit in this country at the present day than an ore of tin. All of our tin is imported from abroad, chiefly from Great Britain and her East Indian dependencies. Hence it easily appears that in case of a war with that power, that our supplies of this metal would be entirely cut off. No ores of tin have yet been discovered in our country of sufficient importance to admit of their being worked.

We are happy to be able to state that there is more prospect of finding valuable ores of tin in Maine than in any other part of the country. A locality of some importance is at Bluehill. The mineral *wolfram* occurs there in granite. This is considered as an indication of tin in the English mines.

A far better indication of tin has recently been discovered in Oxford county, viz., the tin itself, in a vein. A mass of tin ore weighing five pounds has been discovered in a vein in granite on

Mount Mica in Paris. Other smaller specimens, some of which were beautifully crystallized, were also found there scattered through the vein, mostly in contact with albite or quartz. We have not been able yet to examine the locality or the region, but we confidently anticipate in Oxford county the discovery of a rich vein of tin ore. If the dissemination of grains of tinstone is an indication of veins of tin in England, we do not see why large masses of the ore itself, and that in a vein, are not a far better indication of important veins in this country. We would recommend to the citizens of Oxford county and all others interested to take this matter into their own hands, and not wait for the action of the government. Let them thoroughly examine the rocks on their farms and save specimens of all suspicious rocks to be pronounced upon by those who are familiar with their value.

Tin ores are found in granite in Europe. They often have so little the appearance of metal that they are passed by as worthless by those not familiar with them. They generally have a deep brownish or rusty red color, and are compact and heavy, somewhat resembling the ores of titanium or rutile.

Manganese and Arsenic.

Manganese and arsenic occur in Maine in considerable amount, but their value is not great, as the use made of them is small. Still it is well to know that we have in the State the means of procuring these metals, as at some period the knowledge may be of service.

Manganese ores occur in two forms; in alluvial deposits similar to an often associated with bog iron ore; or in veins of considerable extent in the solid rock. The alluvial ore is called *manganese wad*, and appears both as a black powder and in small rounded or irregular shaped concretions. Its origin is similar to that of the bog iron, having been derived from the decomposition of rocks containing perhaps only a small per cent. of the ore. A bed of considerable size is found in Thomaston, upon Dodge's Mountain, where it has attracted much attention. It has been noticed in Bluehill, Paris, Dover, Mt. Agamenticus, on the east branch of the Penobscot, and will doubtless be found in fifty other localities. The ore at Bluehill is in an enormous bed on Osgood's Mountain, and is not alluvial. It is thirty-six feet wide, and of unknown length. In Hodgdon we found the strata largely composed of manganese in one part of the town. Though not of sufficient amount in the strata to be worked, we would recommend the examination of the bogs in the neighborhod for beds of the ore, in case the metal is ever needed greatly. As similar manganesian strata are associated with the hematites of Hodgdon, Linneus and Waite, we would recommend as before the examination of the adjacent bogs. We found some manganese in the rocks on the west shore of Matagamon Lake, in No. 5, R. 8.

Arsenic is found in arsenical iron and arsenical pyrites, and is as abundant in the State as the manganese ores. The arsenical iron occurs in veins in granite, syenite and trap. It occurs in Bluehill, Fairfield, Thomaston at Owl's Head, Newfield on Bond's Mountain, and in Greenwood on Furlong Mountain. The arsenical pyrites occurs at Owl's Head in Thomaston, on Titcomb's Hill in Farmington, and doubtless in connection with beds of the ordinary iron pyrites. The specimens from Greenwood resemble native arsenic, and were taken from a vein in granite three inches wide. It is also found in small masses at other localities in the vicinity.

Gold.

There is an extensive tract in the north-west part of the State in which native gold has been found. It has been seen only in the alluvium, from which some inferred that it came from Canada. We cannot speak from observation, more than from specimens, concerning the occurrence of gold in a portion of this region. We refer to the country watered by Sandy River.

Gold was first found in Madrid by a returned Californian miner. It has been found on the Sandy River at various localities between its source and New Sharon. Specimens of it from Mount Vernon have been presented for the cabinet the past season. Between Sandy River and the Canada line gold has been found in many places. One man dug out $30 worth on Sandy River.

These facts show that there is gold *in situ* in the rocks of Somerset and Franklin counties. We do not think it is all derived from Canadian boulders. It is too widely distributed in the soil, and is too abundant to be of foreign origin. Gold is by no means confined to talcose schist, but may be found in veins in most of the azoic rocks. The rocks of these counties are largely azoic.

Another gold region we are persuaded exists further north on the upper part of the St. John River. The talcose schists there are the same variety of rock as those in which gold is commonly found. The rock is the same as that which has yielded gold in the Southern States, in Vermont, and on the Chaudiere River in Canada. Specimens of gold have been found on the St. John also.

Whether these localities will afford an abundance of this precious metal can be determined only by actual mining. No effort has been made to discover the quartz veins containing the gold; all that has been obtained being only the particles that have been worn off the productive ledges. The mining of the gold-bearing quartz is now considered more profitable, in gold regions, than the washings.

In these quartz veins and the alluvium, the gold occurs as the pure element, unless it be alloyed with a little silver. But it may occur in Maine in another form. It has been discovered that many deposits of iron pyrites contain much gold, which is not discovered by the ordinary rules of analysis. It is a disputed question in what chemical form the gold exists in the pyrites. The pyrites gold mines are often more valuable than the quartz leads, since a new process has been discovered by which the pure gold may be easily extracted. We need only refer to the large beds of pyrites in Maine to awaken the suspicion that much gold may be contained in them. The fact may easily be determined by the chemist.

We have not included Albion as a gold locality, on account of the suspicion expressed in Jackson's report as to its genuineness.

The operation of washing for gold is called *panning*. A common tin pan is filled with earth, and then placed under water in a tub or stream, and the whole shaken in a peculiar manner. The earth is presently all washed away, leaving only the gold at the bottom. Soil is said to pan well or poorly according to the amount of gold found in the panful of earth.

Silver occurs in combination with lead and gold in Maine, but not in any considerable amount.

Iron Pyrites.

No mineral is so common in Maine as this. There are very few towns where it may not be found in the ledges. Still it is not common to find it in great beds; and it is not of economical value unless it occurs in large amount. No mineral has so commonly been mistaken for gold as this. It is of a bright yellow color, crystalizing in cubes, and has received the very appropriate appellation of *fools' gold*. It is brittle, and when heated strongly gives out a sulphurous odor; which two properties readily distinguish it from true gold, as the latter is malleable, not brittle, and gives out no odor when heated. Pyrites is composed of iron 46 parts, and sulphur 54 parts. Chemically, it is a bi-sulphuret of iron.

The rock on Jewell's Island in Casco Bay is a pyritiferous mica schist, or a mica schist highly charged with pyrites. There are three beds of the highly pyritiferous rocks, and these are several rods wide. The rock on the north-west side of the island forms a wall from fifteen to thirty feet high, so that an immense amount of the pyritiferous rock is above the ocean level. Upon the surface of the rock, the substances formed by the decomposition of the pyrites appear occasionally; which are copperas or the sulphate of iron, and alum or the double sulphate of alumina and potassa. The same pyritiferous strata crop out on Cape Elizabeth. There was formerly an establisement on Jewell's Island for the manufacture of alum and copperas.

In Brooksville, opposite Castine, there is a great abundance of pyritiferous clay slate, alternating with ordinary clay slates. There is no danger of exhausting the locality for many years.

In Troy, there is a still larger bed of pyritiferous slates, with a large bed of pure pyrites. This rock could be more easily decomposed than most of the slates.

In Anson, on Mr. Churchill's farm, there is a large bed of pyritiferous slate, but it is not so valuable as the one just noticed. There are two localities in Farmington. Norton's Ledge, 380 feet high, is composed of mica schist charged abundantly with pyrites. There is an inexhaustible supply of pyrites present. The other locality is on Powder House Hill. Another locality has already been noticed, viz., in the limestone at Drew's Mill, in New Limerick. This is pure pyrites, and no alum could be made here. Owing to the mixture of limestone with the pyrites, some gypsum would be formed by the decomposition. The pyrites is sufficiently abundant for the manufacture of copperas or sulphur. No doubt many other large deposits of pyrites occur in the State.

The substances that can be manufactured from pyrites are copperas, sulphur, alum, and carbonate of soda. The copperas is formed from the direct oxydation of both the sulphur and the iron, making sulphate of the protoxyd of iron. This change will take place without assistance, but may be expedited by a slight roasting of the ores. In the manufacture of the salt, piles of ore are being constantly permeated by water, which dissolves all the sulphate. This water is then evaporated, and the copperas crystalized out.

Sulphur may be formed by roasting the ore. It is not so economical a method of preparing sulphur as the obtaining it from volcanic regions; but sometimes it becomes a matter of necessity to manufacture it from pyrites, as it is now in the Southern States. In case we should be at war with Great Britain, our supplies from abroad might be cut off and we be obliged to manufacture it from pyrites. In such a case, Maine will afford an abundance of material for the manufacture of sulphur. The chemist, in his report, will speak further upon this subject; also upon the manufacture of saltpetre.

Alum is formed partly from the pyrites and partly from the rock. The sulphur of the pyrites becoming sulphuric acid unites with the alumina and potassa of the slate, forming a double sulphate. It is only occasionally that all these substances are present, but very easily performed experiments will decide the question. The opportunities for the manufacture of alum in the State are very great.

The carbonate of soda can be formed by the combined action of the decomposition of pyrites with carbonate of lime and sea water. First produce the copperas; then mix it with sea water, when sulphate of soda or Glauber salt will be formed. This may be crystalized out and then decomposed by carbonate of lime, with the aid of heat, when carbonate of soda will be the result. Gypsum will also be formed, but it is not of sufficient value to be preserved. Carbonate of soda is used in the manufacture of glass and soap.

Engineering and Architecture.

We can easily, under this head, treat of the materials used for both engineering and architecture. The engineer must locate railroads, turnpikes, canals, excavate tunnels, construct embankments, quays and bridges. The architect must select the sites for dwellings; and both must choose suitable materials for their works. Both must consider the locations of their works, and the materials to be used in construction. Geology can assist both.

In the construction of all kinds of roads, attention must be paid mostly to the character of the loose materials, whether the road shall run over clay, sand or gravel. A little knowledge of geology, particularly of theoretical geology, may show the engineer a great superiority of one route over another. For example, he may construct a road along an alluvial valley lined with terraces. One terrace is uniformly composed of sand or loam; another of clay, and the third of gravel. In fact, this is generally the character of the three lowest terraces as has already been stated. Now if the engineer could only know this before the road is built, it would be of great service to him. The same principle will apply to the selection of sites for dwellings. Many buildings are ruined by want of discretion in the choice of the site. In this case, the character of the underlying rocks must often be known.

In cutting through rocks, a little practical knowledge of them will often save immense labor; for example, in the construction of a tunnel. Rocks excavate very easily, when the cut is made through the broad face of the strata. To cut through the edges of strata, requires double the labor. A geologist, too, can judge of the nature of the rock in the interior of the hill or mountain tunneled. If for any reason the rock in the interior is a trap rock of a certain character, the engineer must calculate upon a task as difficult as to blast iron. The principles of geology are also required in the location of Artesian wells.

These remarks have been thrown out at random, as it would be impossible for the geologist of a State to point out the advantage of one specific location over another in a report. We only argue that if the principles of geology were well understood by engineers and architects, their labors would be rendered much easier.

When we come to speak of the materials to be used for building purposes, we can dwell particularly upon the character of the best materials. For most common purposes men are obliged to use such materials as are the most accessible without regard to quality. In connection with valuable materials for building purposes, we shall speak also of several articles of a miscellaneous character. We shall speak of granite, gneiss, freestone and other building materials; then of flagging and roofing materials; next of ornamental articles such as marble and serpentine, of lime, cement, glass sand, clay for bricks, honestones, etc. We must necessarily be exceedingly brief.

Granite and Gneiss.

Granite and gneiss may be connected together in this notice, since both answer the same purpose, and are called by the same name among workmen. Their value for building materials need not be dwelt upon, as their merits are well known. We will only speak of certain localities where they are or might be quarried to advantage.

There is no State in the whole Union where the facilities for quarrying and transporting granite are so great as in Maine. Quarries line fully half of her seaboard, so that the very cheapest mode of transportation is at hand. Add to this, that south of Cape Cod as far as Mexico, the coast is entirely alluvial, and that for a great distance inland, so that the seaboard towns can procure their granite from Maine cheaper than from their own States, if the rock occurs there. Whatever be the political relations of the States, the supply of granite must come from the north.

Granite, syenite and gneiss (while all answer the same purpose) are found in inexhaustible quantity and of proper character for building materials in Kennebunk, Biddeford, York, Newfield, Waterford, Phipsburg, Edgecomb, Wiscasset, Brunswick, Hallowell, Augusta, Friendship, St. George, most of the islands of Knox and Lincoln counties, Brooksville, Bluehill, Frankfort, Mt. Waldo, etc., Sedgwick, Sullivan, Mount Desert, Gouldsborough, Calais, and all the immense granite regions of Hancock and Washington counties, the Katahdin region, and a hundred other localities, for a general notice of which we would refer to our remarks on the distribution of gneiss, granite and syenite. There is enough granite in the State of Maine to build all the cities in the world. So great is the amount of good granite in the State that we cannot have time more than to allude to the quarries that have been known for the longest time, although the quality of the stone in them is no better than in a hundred other cases not mentioned. We are not able to give the present statistics of any of the quarries.

The best known localities are along the coast. In Kennebunk, there are the United States, the Ocean, the New York and Kennebunk quarries, and others. The granite contains very many crystals of black mica, thus giving it a dark color. Its feldspar is pure white and glassy. The quartz is in very small amount. The stone procured in Kennebunk is largely sold in New York.

The Hallowell granites are universally known. The granite is taken from a ridge running north-east and south-west, elevated about 400 feet above the Kennebec river. The rock is really gneiss. Feldspar is the principal ingredient in this rock. It is white, while the mica is silvery gray. It is fine grained and looks beautifully when hammered smooth. Blocks can be obtained here weighing more than a hundred tons.

The rock in the New Meadows Quarry in Brunswick is like that in Hallowell. A few minute red garnets are scattered through the mass, which add to rather than detract from its beauty. The locality is at Howard's Point, and is capable of furnishing a large supply of building stone. The Phipsburg stone is similar to the Brunswick and Hallowell rocks.

The Wiscasset and Edgecomb granites are properly in the form of beds, though of great size. The latter is dark colored, containing a considerable black mica, and has been largely shipped to New Orleans.

The coast of Lincoln county and the islands adjacent abound with granite. A great deal of granite from Seal Harbor has been transported to New York, and was used also to construct Fortress Monroe in Virginia. The State own several granite quarries in this vicinity.

Mt. Waldo, Mosquito Mountain, and Treat's Mountain on Penobscot bay, are composed of most excellent granite. The first named is the largest, and is a huge pyramid of granite. The granite is of the porphyritic variety, splits well, may be wrought into almost any shape, and will appear well in any kind of building. The quarries were opened upon this mountain in 1836. The rock at the other mountains on the Penobscot yield granite of the first quality. Several companies have been quarrying granite in Bluehill to advantage. The rock is rather coarse grained but is very handsome when hammered. The granite in Brooksville is of a similar character. Immense granite quarries are worked in Sullivan; viz., Stimpson's and the Mount Washington quarries. We think none of the quarries now worked can furnish stone superior to that in the immense granite ranges of the two south-east counties of the State. We would say more about the granite quarries, did they not loudly speak for themselves. They constitute an immense source of wealth for the State.

Freestone, etc. The Devonian sandstones of Washington county will afford in some localities very good freestone. A quarry of this rock has been worked in Perry, about half a mile from the post office, by the St. Croix Coal and Freestone Company. The stone is of good quality, like the famous Portland freestone of Connecticut. Other localities will be found in the vicinity. The red sandstone of Machiasport may yield a stone that will be superior to the ordinary loose freestone, because it will resist decomposition for a longer period.

It is curious that the popular building materials used in Europe and America should vary so much. With us, granite is very popular, though not exclusively used. There the freestones and oolite rocks are the common materials used. They are not as enduring as our granite, still many of them are as firm now as centuries ago when they left the quarries.

The trap and porphyritic rocks of the south-east counties are often suitable for building materials. With some, they are very popular.

It is an important and difficult point to ascertain how long a rock will resist disintegration. When buildings have been erected for many centuries, as in the old world, this point can readily be determined. But in this country, where all our edifices have been constructed recently, we must resort to other means. The mineral composition will aid us somewhat. The more perfectly crystalline the rock is, the more enduring it will prove in general. A better method is to examine the ledges where they have been exposed to atmospheric agencies for ages, and observe the amount of wear and decomposition. Some artificial chemical methods may also be used.

Flagging Stones and Roofing Slate.

Mica schist adapted for flagging stones abounds in the State. At Phipsburg, near Small Point Harbor, is one locality; and there are others in the mica schist in Winthrop, Acton and Lebanon. The Phipsburg schists are very beautiful, though not as strong as desirable. Some of the fine sandstones in the northern part of the State would do better service; but they are too remote at present from the market. Other localities furnish flagging stones which are used locally to a great extent.

Roofing slate occurs in Maine of the best quality, and like the granite, is inexhaustible in amount. Quarries of it may be worked both tolerably near the salt water, and far in the interior. Discoveries of new slate quarries will constantly be made, and the demands for the slate will be constantly increasing, as it is used for many purposes besides roofing.

A grand belt of roofing slate extends from the Kennebec river at Caratunk nearly to the Penobscot river, a distance of 80 miles. The quarries that have been worked, are all upon this belt.

Upon this belt, good roofing slate has been noticed at Caratunk. Slates can be split out there from three to six feet square.

Another locality is in Foxcroft. They occur also in Williamsburg, Brownville, Sebec and Barnard in the settled districts upon this belt. We have seen specimens from Brownville that have been wrought into other articles besides roofing slate. It may be used for blackboards, tables, writing slates, slate pencils, floors of houses, fences, troughs, and in fact for almost everything for which boards are used. It can also by a new and cheap process be made to imitate all kinds of polished marbles, serpentines, porphyries, etc.; and the use of the imitation stone for fire-arms, tables and the other ornamental purposes for which slabs of elegant colors are required, is greatly increasing. The slate quarries of Maine may prove as valuable as the granite quarries, though less in number.

Mr. Houghton was requested to report upon the slates of Brownville and vicinity, and we beg to refer to his valuable report upon them in Part II. In our expedition in Northern Maine we found large districts which will furnish abundant quarries of roofing slate, if the demand shall ever be sufficiently great for them. We should expect to find quarries of roofing slate upon portions of the St. Francis and Alleguash Rivers. We found two such localities upon the St. John River, one at the mouth of Black River, and the other three miles above Green River. As so much of the rock of Northern Moine is clay slate, the localities of good roofing slate will be found in scores of instances, when that region shall have been explored for the purpose.

We give here an account of another good locality, discovered the past season by Dr. Holmes, belonging to the Brownville belt of rock:—

"*Another Slate Quarry.* The slates of Maine are beginning to be appreciated. The notice that a formation of good slate had been found in No. 13, R. 3, in Aroostook, has attracted general attention, as being another evidence of the valuable geological characteristics of that section of the State. A knowledge of our geology is a great desideratum, and the ascertaining of facts of this kind and spreading them before the public is the object and duty of the Scientific Survey now in course of prosecution.

"It may not be amiss, therefore, to say that another formation of slate in which might be opened an excellent quarry, was examined by a party of that survey, in No. 3, R. 8, from north line of Waldo Patent, (marked No. 3, R. 4, from Bingham Purchase, on Greenleaf's map.) There were two localities of this slate examined. One of them cropped out on the banks of the Seboois Stream, crossing it in a N. N. E. direction. Here is slate of good quality. It is of good color, tough, and of good cleavage, and the amount probably inexhaustible. On careful examination there could be seen but one objection to opening a quarry at this place, and that was its proximity to the water. On getting down a moderate depth it would be expensive, if not impossible, to keep the water out. It occurred to the party that by following the strike of the ledge over the hill near by, it might possibly be found cropping out at a higher elevation. On making the search this was found to be the case, and fine specimens were there procured. Here there is elevation enough to make it a very easy matter to avoid trouble from any water in the quarry.

"This locality is looked upon as being valuable also on account of its proximity to the boat navigation of the Penobscot River. By cutting a new road over good roading ground, say from three to five miles, you are brought into a very good road already made, which leads you, in the course of seven or eight miles, to the mouth of the Piscataquis River in Howland, where the Penobscot steamers stop during boating stage of the water. This would facilitate the getting of the slate to market by material reduction in the cost of transportation from that of any other quarry at present open in Maine. The truckage would probably be from a third to two-thirds less than from any other quarries. The land in this township is excellent settling land, while there are several good mill privileges where settlers could have the conveniences of grist and saw mills so essential to the comfort of a people.

"There are good thrifty settlers now within three or four miles of the locality of slate referred to, and if any one doubts the agricultural capacity of the lands there, let him go and examine their farms, and be convinced by the evidences of his own senses.

"When the railroad is finished up to Mattawamkeag, there will undoubtedly be a bridge constructed across the Penobscot at the mouth of the Piscataquis, which will render the lands in that neighborhood still more eligible for settling purposes, and greatly improve the material advantages of that section of the State."

Rev. M. R. Keep of Ashland writes as follows concerning some of the roofing slates of Northern Maine :—

"There seems to be in Aroostook county a distinct variety from the Brownville slate and others in common use. That which has the most even rift and seems likely some day to be worked for use and for market, is of a light blue color, and very soft, much like the Rutland freestone pencils, that are much preferred to the black pencils for their softness, and have come into use lately. My attention was first drawn to this fact in noticing some specimens in No. 9, R. 5, near what is called the 'Hews Place,' on the Aroostook Road below Masardis. In that region considerable quantities are found scattered over the surface, and the main ledge is visible in several places, but has not been opened yet. So far as the stone is concerned, some of the best writing slates I ever saw have been made from that owned by Mr. Robert Ready and men in his family. I have one of them in my possession, which as a specimen indicates the best quality of stone for writing as well as roofing slates that I ever saw. The rift is most perfect, free and even, and the texture soft, so as to make good pencils for use on the same or other slate. This same kind of slate and nearly the same quality I found in No. 5, R. 5, also in Patten; and then again in better position for working on the banks of the Mattawamkeag, in township 4, R. 4, where it rises abruptly from the water's edge 20 feet, and a man can without preliminaries cleave off slabs perhaps as large as a barn door. There is no doubt that there is an abundance of this slate in many locations, but the principal nature of a quarry will depend on position for working; it has a strike from north-east to south-west and a dip northward nearly perpendicular. When it can be found on a north-east cant of a hill, and at the same time of the desirable quality, it may prove worth something at a future day for market."

We desire to call attention also to the very fine clay slates of Northern Washington county, where the Calais and Houlton road crosses them in Northern Topsfield and No. 9; also to the same rocks between Patten and Molunkus. We are persuaded that good quarries will be found in both these localities.

Marble.

Marble is less abundant in Maine than granite or roofing slate. It is a species of limestone, being very thick bedded and solid.

That in Maine is not generally of the most ornamental character, and will be more useful for building materials than nice ornaments. Marble is found at Machiasport, Thomaston, Hope, Camden, Sidney, Union, and the northern part of the State. The marble of Machiasport is on the north side of Starboard's Creek, and has already been noticed under the Devonian rocks. It forms two beds on the east side of the point, one of which has been traced across the promontory. The marble is largely composed of fragments of shells resembling a Natica. The most beautiful varieties of this marble are the clouded red, and the red spotted with white. The marble is mostly in two layers, the one ten and the other twelve feet wide. It is not sufficiently abundant to render its working for marble profitable.

A considerable of the limestones of Rockland, Thomaston, Hope, and Camden, may be termed marbles. As the rock is quarried profitably for the manufacture of quick lime, it is not likely that it will be advisable ever to quarry it as a building stone, especially as the most beautiful granite is close at hand. At the Marsh, a dolomitic marble might be obtained. Perhaps a better opportunity for obtaining good marble is afforded by the limestone in Union.

Mr. Wm. Prescott has presented the State with a specimen of marble from Sidney. If it is from a wide layer, it may be a locality of great importance.

We found on the east branch of the Penobscot boulders of a very fine statuary marble, specimens of which may be seen at the State House. It is one of the most promising specimens of marble we have seen anywhere in the State. Without doubt these boulders were derived from a strip of Lower Helderberg limestone, running through the whole of the northern part of the State, and very possibly in two or three different belts. It may belong to the same belt with that discovered by Dr. Jackson in No. 7, R. 7.

The following is a letter from Mr. Franklin R. Basten of Rockabema, to Dr. Holmes, concerning limestone and marble found in No. 7, R. 6, of Aroostook, one township east of the Seboois:

"No. 6, RANGE 5, October 22d, 1861.

DOCTOR HOLMES—SIR: I have just returned from the marble quarry in No. 7, R. 6. The specimens of the marble which I procured are forwarded to you. The marble looks very handsome in the ledge. It lays in sheets about 30 or 40 feet long, from 20 to 25 feet wide, and from 4 inches to 4 feet in thickness. The logging road crossing Big Umcolcus Lake goes within 40 rods of this marble. We had a hard time in finding it. We could not follow the lines at all, and we went entirely around and were about giving it up when we happened to strike on one side of it. * * * The marble was about 75 rods to the north-east from where you and I camped. Respectfully yours,

FRANKLIN N. BASTEN."

The amount of marble in the wild lands is a point yet to be determined by future explorations.

Serpentine and Steatite.

Serpentine is a beautiful ornamental stone, and commands a high price. A large amount of it is found in the northern and north-eastern parts of Deer Isle. It may be traced from Torrey's Pond to the Beach, and is a mile and a half in width. The rock is cut by joints into masses about three feet square. Small veins of asbestus run through portions of the bed. Other parts are filled with the mineral diallage, which appears as yellow spots when the rock containing it is polished. Generally the polished specimens are of a dark green color. The rock is quite soft. The bed is certainly large enough for all practical purposes, and a careful examination will show how great its value is. We were informed of the existence of another bed of serpentine in Sidney, but have been unable to verify the statement.

A rock allied to serpentine in its position, chemical character and origin is *steatite* or soapstone, sometimes called potstone. Mineralogically it is an impure talc, and is known by its greasy feel. It has been found at Harpswell, Orr's Island, Jaquish, and in Vassalboro'. It is not generally of the best quality in Maine. The bed on Orr's Island is fourteen feet wide, and some of it may be valuable. Mr. Lang of North Vassalboro' informs us of the existence of a perfectly immense bed of rock in Vassalboro' similar to steatite. We have been unable to examine it yet. We anticipate the discovery in Maine of many beds of serpentine and steatite. It would be strange if our azoic rocks, which abound with beds of limestone, should not also contain these magnesian rocks.

Limestone.

Like the granite and clay slate, limestone suitable for the manufacture of quicklime is abundant in Maine, and the localities are in the most desirable situations for both the home and foreign markets. No lime is better known throughout the United States than that of Thomaston, Rockland and vicinity, and it is scarcely possible for any lime to be of better quality.

An immense amount of labor is required in the manufacture of quicklime. We doubt whether any other manufacturing business is as general as this, in the State, or employs as many persons. For the manufacture of lime the following sets of laborers are employed: To provide timber for the manufacture of casks; to manufacture the casks, and transport them to the lime districts; to blast the limestone; to transport the rock from the quarries to the kilns; to burn the lime; and to prepare the lime from the kiln for market. We might add to these the persons employed in the transportation of the lime from the kilns to the places where it is consumed. Thus it will be seen that the manufacture of lime is a department of industry of prime consequence to the State.

We regret that we are unable to present the statistics from more than one or two localities of lime manufacture, but must content ourselves rather with pointing out new localities where lime may be manufactured. Mr. Ulmer of Rockland has kindly furnished us the statistics of the lime in Rockland and Thomaston, which we here submit:—

"Rockland, December 9, 1861.

Dear Sir,—I received your letter of the 28th November, wishing to know the number of casks of lime manufactured in Thomaston and Rockland. We manufacture in Rockland about one million casks annually. In Thomaston they manufacture about twenty-five thousand per year. We consume in Rockland about fifty thousand cords of wood per year at the cost of from two dollars and fifty cents to three dollars per cord. Our lime casks cost from twelve to seventeen cents apiece. Limestone at the kiln costs from twelve to fifteen cents per cask; labor six cents per cask; kiln rent three cents per cask. We employ about one hundred sail of small vessels in fetching wood from the eastward, and it takes eighty sail of coasters to carry our lime to market. Our lime is consumed all along our Atlantic coast from Calais to Texas, and nets us about sixty cents per cask. In Thomaston materials the same as in Rockland.

Yours respectfully,

Alden Ulmer, *Inspector*."

It is interesting to compare the amount manufactured now with that burned twenty-five years ago. In 1836, 400,000 casks of lime were burned in Thomaston, and 700,000 casks were estimated as the total produce of all the kilns in the State. This is less than that manufactured annually at one locality at present.

Without wearying you, gentlemen of the Legislature, with a detailed account of each locality where lime may be manufactured profitably, we will present as far as possible a table of the localities, with the per cent. of quicklime which may be made from the different limestones. You are doubtless aware that the purest limestone is composed of 43.7 per cent. of carbonic acid and 56.3 per cent. of lime. By burning the limestone the carbonic acid becomes a gas, and is expelled from the rock. Thus the purest limestone can afford but little more than fifty per cent. of lime. The following table gives the per cent. of quicklime manufactured from 100 parts of the rock:—

Thomaston, (different quarries,) 54.50, 54.51, 47.00.		Dixfield,	44.70
		Farmington, Titcomb's Hill,	49.40
Thomaston, Marsh quarry, 42.1, (21 of which is magnesia.)		Farmington Hill,	47.40
		Guilford,	47.60
Camden,	50.00	Industry,	42.70
Hope,	54.80	New Sharon,	49.60
L'Etang, N. B.,	54.30	Norridgewock,	49.00
Brunswick,	55.06	Phillips,	36.50
Starboard's Creek,	46.60	Rumford Falls,	43.90
Lubec, Upper Silurian,	47.80	Strong,	50.80
Abbot, Witherum's,	41.90	Turner,	42.90
Athens Village,	40.80	West Waterville,	41.40
Carthage, B. Winter,	50.40	W. Waterville, Crowell's,	50.40
Clinton, A. Brown,	43.10	Winslow, Wall,	41.40
Dexter, E. Crowell,	50.60	Winslow, Drummond,	45.90
Dexter, Fish,	50.10	Winslow, Furber,	43.70
Dexter, John Puffer,	47.20	Winthrop,	44.30

Nearly all the above localities will furnish good lime for the ordinary purposes of the mason. From the following places may be obtained a lime of poorer quality, but suitable for agricultural purposes: Winslow, Waterville, Union, Temple, Skowhegan, Poland, Phillips, Norway, Norridgewock, New Sharon, Mount Vernon, Livermore, Jay, Harmony, Hampden, Foxcroft, Forks of the Kennebec, Dover, Dixfield, Athens, Bingham, Carthage and Clinton.

Concerning the limestones which have not been analyzed, we would say a few words. In Carroll, lime is manufactured extensively. From 300 to 500 barrels of lime are produced there annually upon the farm of Mr. Gates. Sixty barrels are manufactured annually from a ledge of limestone on Square Lake in No. 16, R. 5, of Aroostook. At Drew's Mill in New Limerick lime of good quality is manufactured extensively.

Scarcely anything is of so great value in a new country as good beds of limestone from which lime can readily be procured. We have the satisfaction of reporting the discovery the past season of a belt of most excellent limestone, and perhaps several of them running through the very centre of the wild lands of Maine. The belt extends probably from Moosehead Lake to near the Grand Falls on the St. John River in New Brunswick, a distance of 150 miles, and is often 100 feet thick. If any one has been anxious to learn of the existence of lime in Northern Maine, he will surely be gratified to learn that it occurs in such immense quantity.

We of course have been unable to trace out this belt of limestone over its whole extent, having seen it only at several localities. But the rock is so situated that we are willing as a geologist to declare that if the principles of the science can be depended upon, an enormous amount of pure, generally white limestone and marble occurs along the line just indicated, and in some parts of the course in more than one belt. We have observed it at the following places: On Moosehead Lake, at Ripogenus Falls on the west branch of the Penobscot, in boulders on the east branch of the Penobscot all the way from Winn to the Grand Falls, on Horseshoe Pond in No. 5, R. 8, in No. 4, R. 7, in No. 6, R. 7, in No. 7, R. 7, in No. 7, R. 6, in Ashland, in No. 13, R. 5, in No. 13, R. 7, and on the west side of Square Lake. This rock is represented upon the map as the Lower Helderberg group, as it belongs to that formation in the Upper Silurian series.

We cannot too strongly urge upon the government the importance of tracing out this band of limestone, that its exact limits may be known and also the most favorable situations to work it either for marble or lime. The Aroostook region is destined to be thickly settled in the future, and every additional resource of the county that is made known will encourage immigration thither. So important are the geological relations of this belt of limestone that if they were explored scientifically as well as practically, geologists from other States would visit them from motives of scientific interest.

Water Lime or Cement.

A lime that will harden under water, or one that will resist the dissolving action of water, commands a higher price than the ordinary lime of the best quality. It is only by experiment that the value of a rock for the manufacture of water lime can be ascertained, as chemists have not yet been able to discover precisely what the essential quality of the cement is that resists the action of water so successfully. A large number of the limestones of the State appear to us to be of nearly the right quality for the production of this valuable substance, particularly the Upper Silurian limestones about Lubec and Pembroke.

A still better rock is found at Starboard's Creek, and its analysis shows us about the right composition of the limestone to be used for the manufacture of this cement. It contains—

Silica,	14.00
Alumina,	15.00
Oxide of manganese,	4.00
Carbonate of iron,	6.00
Carbonate of lime,	59.50
Water,	1.50
	100.00

Another favorable limestone for hydraulic cement occurs near Capt. Thompson's house, near the end of the Point of Maine. We procured specimens for analysis, but the chemist has not yet had time to examine them. We expect that hydraulic limestone will be found in Aroostook county.

Materials for the Manufacture of Glass.

Glass works are generally erected in the vicinity of an abundant supply of pure silica or quartz, as the other necessary materials can be more easily transported. An abundant supply of pure quartz, such as is necessary for the purpose, is found in Maine, as already described. The two best localities are at Liberty and Camden. Quicklime or pure limestone and carbonate of soda or potash are the principal other ingredients needed for the manufacture of ordinary glass. All these articles can easily be obtained in the vicinity of the two localities of quartz mentioned above, as well as the necessary fire wood, at very cheap rates. Perhaps some enterprising person familiar with the manufacture of glass may be disposed from this representation to erect works of this nature in Maine. The citizens would certainly welcome him.

Materials for the Manufacture of Bricks.

An abundant supply of plastic blue clay suitable for the manufacture of bricks, tiles, etc., will be found in the marine clays along the coast and the principal rivers, and along the alluvial clays in the same and other river valleys to a great height. We simply desire to call attention to the fact that an abundant supply of this clay occurs on the St. John River between the Grand Falls and the mouth of Little Black River, so that the new settlers in the northern part of the State will not be obliged to suffer for the want of such useful articles as can be manufactured from these clays.

Honestones and *whetstones* are cheap articles but of some importance, particularly in a region where the materials for their manufacture are scarce. The abundant bands of mica schist, and sometimes the talcose schist in the State, will afford whetstones, and the novaculites will furnish honestones of excellent quality. There is a beautiful novaculite in the north-west part of Deer Isle, which would be well worth working for honestones. The material is fully equal to that from any other locality in New England. In Kennebunk and York are other localities of novaculite, but inferior to the Deer Isle specimens. Some boulders of novaculite are found at Phillips, indicating the existence of the mineral in places in the vicinity.

Agricultural Geology.

We will say but a single word upon this topic, as it is not in our department of the survey.

Geology can assist the agriculturalist by pointing out the origin of different soils, and natural deposits of fertilizers. Soils are formed in two ways: 1, by the decomposition of the adjacent rocks, with the addition of animal and vegetable matters; 2, by the addition to the natural decompositions of rocks, gravel and sand that have been transported from a distance by the drift agency mentioned above. It is easy to see that the determination of the character of the soil is rendered much more difficult by the accumulation of these loose materials. Still they are often a benefit to the soil, because they add to it certain qualities which it needed and would not otherwise have possessed. Most of the soils of Maine are of the latter character.

It is very obvious that a protracted examination must be made of the whole State by the agriculturist and geologist of the Survey before much benefit can be derived from their labors. The facts must all be collected together before conclusions can be drawn from them, and one year's labor can only be preliminary. It is our purpose, if the explorations are to continue, to make out a map of the State, showing by colors the extent of the different kinds of soil everywhere within it. There will be perhaps ten different kinds of soil to be represented; and in the notes accompanying the map would be explanations of the character of each of these different kinds of soil, with a statement of their deficiencies and the kinds of fertilizers that are best adapted to improve them. The best kinds of soil are the loamy alluvial soils of river meadows. The second best are those rich soils derived from the decomposition of calcareous rocks, like those in the eastern part of Aroostook county. We say without hesitation that the best farming region in the State is in Aroostook county. The soil there is not of the alluvial character, but is the best of upland soil. To illustrate the bearings of geology upon agriculture, we would say that the limits of one variety of this excellent soil may be seen by consulting our geological map of Northern Maine in Part II. That part of it which represents the distribution of the calcareous slates shows also the area occupied by this fine soil.

Natural Fertilizers.

Marl, peat and marine manures are the best natural fertilizers in Maine. The distribution of the first has already been noticed, when we spoke of its wide-spread distribution in Northern Maine. We believe it is the duty of the government towards its citizens in that region to explore these deposits. The latter class of deposits are ably treated of in the Report of the Secretary of the Board of Agriculture. The second kind are most extensively developed in Maine, as is well known to most of its citizens. We would only notice five or six localities of large size, where the peat may be used for fuel as well as a fertilizer. Hundreds o other bogs occur in the State. The ones noticed are on the railroad west of Bangor; at Bluehill; near the marsh in Thomaston, in Limerick, Waterford, and on Ambejijis Lake near Mt. Katahdin. Some of the marls contain phosphates which are of the greatest value as fertilizers. Mr. Goodale's chemical report will show the amount of them. The marl can also be burnt for lime if need be.

PART II.

PHYSICAL GEOGRAPHY, AGRICULTURAL CAPABILITIES, GEOLOGY, BOTANY AND ZOOLOGY OF THE WILD LANDS IN THE NORTHERN PART OF THE STATE.

NOTES AND SKETCHES

OF THE WILD LANDS EXPLORED.

BY E. HOLMES.

Progress of the Party.

If you examine a correct map of Maine, and cast your eyes upon that portion of it that gives a delineation of the valley of the Penobscot River, you will find that, with the exception of the St. John, it is the largest river in our portion of that peninsula which was spoken of in a former part of this Report. You will see that it drains a much greater extent of territory than any one of the rivers within the bounds of Maine proper. If you commence at its mouth and trace up its course to the east branch—thence up this branch to Chamberlain Lake, you will also see that it there connects with the waters of the St. John tributaries, affording canoe and batteau navigation from its mouth northward, across the widest portion of the State, up to the monument on its boundary placed at its most extreme northern limit on the shores of Boundary Lake on the Canada borders, in all not less than three hundred miles. This navigation may be continued into that province some fifty or more miles further.

This water communication, at an early day, formed the grand thoroughfare through which the Indians of the St. Lawrence communicated with those on our Atlantic coast. These connecting waters allowed them continuous navigation for their light craft, except a few short "carries," or portages, by the heavier falls and rapids, or over shorter routes where distance might be materially saved by cutting across curves, or circuitous courses of the rivers and lakes in the route.

Traditions, among the elders of the Penobscot tribe of the present day, tell of the descent of the Mohawks down the river by these channels, and of the battles and skirmishes had with them on the lower Penobscot long before the white man came among them.

The accidental turning up of the fragment of an ancient sword blade, by one of our party, in the sand of the shore, near one of our camps on Lake Montagamonsis or Second Lake, proves beyond a doubt, that some of the voyageurs through those waters carried other weapons than those necesssary for the chase, or for use in the peaceful arts of life.

This long stretch of waters, and the wild lands drained by them above the mouth of the Sebois, had never been explored save by the lumberman and the hunter. Its geological features and mineralogical productions, its physical geography, and its natural history, had, up to the date of our expedition, received no special attention, nor had its agricultural capabilities, though tested in a few localities by enterprising lumber proprietors, been made the subject of particular inquiry or public report.

That a section of the State of such extent and probable importance should no longer remain a sealed book, we were directed by the Governor and Secretary of the Board of Agriculture to prepare the necessary flotilla of canoes and batteaux and assistants, and to give it as thorough an examination as could be done in the months of August and September, and report the results. Accordingly, on the 7th of August our party embarked at Oldtown for the contemplated survey in a batteau and three birch canoes,* furnished with the necessary quantity of supplies, comprising equipments and apparatus required to facilitate our researches and inquiries on the rivers and lakes in the forest to be traversed.

The progress *up stream* in such a primitive craft, even on a favorable pitch of water, must necessarily be slow and toilsome, but at low stages it must be slower yet by reason of the delays in looking out the deepest channels and the time lost in working over bars and shoals where there is scarcely sufficient depth even for the light draft of our canoes. On account of the low stage of the water at the time of our embarkation, the steamers that ply between Oldtown and Mattawamkeag were hauled up, and the facilities of transportation which they would have afforded and the consequent saving of time were denied us. We had therefore to depend upon our own navigation for conveyance through that section of our route, thereby consuming three days of our time, when one would have been sufficient, could we have availed ourselves of the agency of steam, as is usual in the early and later parts of the season.

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* The following persons were employed as boatmen and assistants, viz., Benjamin Thomas of Maxfield, Edmund H. Davis of Wayne, Calvin Dearborn of Winthrop, William A. Johnston of Bangor, A. B. Farrar of Bangor, Manley Hardy of Brewer, and Louis Ketchum of Oldtown. Subsequently Dean Murch, with his canoe, was engaged at the Hunt farm as additional help through the season.

On the third day from our departure we arrived at "Nickatou," or the west branch of the Penobscot, which, to those bound up the east branch of the river, may be considered the end of the road, and the point where you bid adieu to civilization and take your plunge into the wild country. There are but four settlers on farms above Nickatou village and the Hunt place in No. 3, and but nine in the whole range of country between Nickatou (west branch) village and the mouth of the Alleguash on the upper St. John—a stretch of not less than 150 miles. The cause of this may be attributed to the fact that every township in this route is owned by proprietors who have hitherto held it for lumbering purposes. The State having disposed of its interest in the lands has not, of course, been called upon to aid in opening it up to settlers. The proprietors, content with the gains given them from the lumber, are not desirous of having them settled, thereby avoiding any calls of taxation for roads, or risks from fires which might take place in clearing the lands. No particular obstruction was met with in our canoe progress until we came to Whetstone Falls, where it became necessary to unload and carry by, a distance of half a mile. At this place the geologist met with boulders of "encrinal" or fossiliferous limestones and other boulders containing fossil remains which have been brought down from sections above. After getting by Whetstone Falls, a few hours brought us to Hunt's Farm, which is situate about midway of No. 3, Range 7. For more than thirty years this farm has been a welcome station, or resting-place for the lumberman and voyageur as he passes up or down the river, and the probability is that it will continue, for years to come, to offer the same conveniences as heretofore, holding the monopoly of affording entertainment to the traveller for want of a rival establishment of the kind in the neighborhood. A road was some time since made from this place into the Aroostook Road at No. 3, Range 6, some twelve miles distant. The soil and agricultural capabilities of this farm give a good criterion by which to judge of the surrounding lands in regard to their value for agricultural purposes. A large portion of it is interval, or alluvial soil on the margin of the river. The remaining portions in the rear, are high swells or ridges. The interval is well adapted to grass, being in its lower parts inundated in the spring of the year, and thus fertilized by the fine particles left on the subsidence of the waters. The higher portions are easily cultivated and very productive, and the swells or uplands afford excellent pasturage for stock. There are immense tracts of similar interval on the Penobscot and its branches near by (the Wassataquick and the Sebois) now covered with forest and wild grasses which grow there in the rankest luxuriance, awaiting the hand of some future settler to subdue and convert them to smiling and productive meadows and fields, and thus enable them to contribute to the subsistence of man and to the wealth of the State.

By previous arrangement we were here met by the Rev. Marcus R. Keep of Ashland, who has done so much as a pioneer explorer of Katahdin, and made known to the public the characteristics of that grand old mountain, in regard to the sublime and extensive prospect seen from its summit, its peculiar geological structure, and the rugged toil required to ascend to its pinnacle. A portion of our party, viz., Messrs. Hitchcock, Goodale, Packard and Davis, immediately on our arrival placed themselves under the guidance of Mr. Keep, who was also accompanied with Mr. Maxwell of Golden Ridge, and left for the purpose of ascending the mountain and making a reconnoisance of the country on the way to and from it. As this would take them three or four days, the remainder of the party agreed to wait for them and employ themselves in repairing boats, exploring the vicinity of the farm, and such other business as the furtherance of the expedition might demand.

As we before stated, the Penobscot, and the Wassataquick, which comes in on the west side, and the Sebois coming in on the eastern side further up, are bordered with large tracts of interval land, made up of the fine alluvium brought down by the waters of the respective streams. The uplands in the rear are somewhat stony or rocky, on account of the boulders which have been strewed over them at some former period. Among these boulders are found limestone of the description before mentioned, and conglomerates and old sandstone of large size, indicating that they had not been removed far from their parent bed, wherever it might be.

The Katahdin party returned on Saturday afternoon well satisfied with the *labors* as well the results and fruits of their expedition, and on Monday morning (18th) we again pursued our voyage up the river. Before night we came to the foot of Grand Falls, and there camped. The Grand Falls, so called, are a series of rapids and cascades extending several miles, with occasional intervals of slack water between some of the pitches. The whole form the most formidable obstruction in the river between Oldtown and Grand Lake. It was a good day's work to get our "luggage" and boats up to the foot of the first or upper pitch, and we found it necessary to camp, reserving for the next morning the remainder of the "carry" and the getting up to "Camp Johnston" in No. 5 in the 8th.

The next morning and day proved somewhat rainy, but taking an early start we accomplished the rest of the "portage," and once more embarked. We found for a mile or two slack water, after which a pretty smart current met us and continued until we came to "Stair Falls." An entirely different rock formation is found from the head of Grand Falls. Granite has entirely disappeared and given place to trap rock and sandstone. Stair Falls are formed by ledges of the latter crossing the river at right angles, and for nearly or quite a mile flooring the river in successive steps or "stairs." In the rocks of the lower step, on the east side, were found "trilobites" and other fossil remains very interesting to the geologists of the party. Even "Louis"—who, by the way, is a shrewd and active member of the Penobscot tribe, and no mean representative of the aboriginal race—became very expert in hunting up specimens of the kind.

On the 23d we arrived at Johnston's Camp in No. 5 of the 8th. This camp had been constructed two year's previously by one of our party (William A. Johnston) and his partner for the accommodation of their men while lumbering on this township, and we found it a very convenient stopping place for a few days, and from which different parties could proceed to examine the several localities in the neighborhood which promised to be interesting. These were the adjacent mountain, called the "Traveller," and some of its spurs; the rock formation at the dam at the outlet of the lake a mile or two above; the Stair Falls below and Bowlin Pond; Jerry Lake and Murch's or Horseshoe Lake on the eastern section of the township. The trap rock of the mountains, the "Silurian rock of the Stair falls" and the fossiliferous limestone in and about Murch's Lake afforded localities of interesting research and employment to the geologist. Suites of specimens from each were collected, all of which will be enumerated and described in Prof. Hitchcock's final Report. We also obtained many interesting specimens in the several departments of Natural History, especially in Ornithology, Entomology and Botany.

The raven (*Corvus corax,*) the large red-headed woodpecker (*Picus pileatus*) and several other rather rare birds were here procured. While Prof. H. with a party proceeded up Grand Lake (Montagamon,) we, in company with Hardy, Murch and Louis proceeded to the exploration of the eastern portion of the township and the lakes in that section. Our first point of examination was Bowlin Pond. Nothing very interesting presented itself in this vicinity except the remains of immense pines which were destroyed by the fires in 1825, the trunks of which are now mostly fallen to the ground and lie quietly mouldering away. All of them were large and some of them of enormous dimensions.

This was once undoubtedly one of the most heavily timbered sections of any part of Maine. In threading our way slowly over these fallen monarchs of the forest, we could not but be struck with the evidences of the vast loss that has accrued to the State by the sweeping of fires through its forests and timber lands. Millions of dollars could not replace the value, or make good the destruction thus made. Some, who pretend to know the facts, assert that the fires, which caused the destruction of the timber in this particular locality, were intentionally set by way of revenge for the loss of some hay burnt by some of the employees of the Land Agent, which hay belonged to some trespassers on the public lands. If this be true, it was a revenge the effect of which will live long after its perpetrators have passed away, and which more than one generation will look upon with regret. Much of this timber was cut and carried away soon after its being burnt, but thousands and thousands of these once stately pines lie strewed about, having fallen in every direction. The growth that is now springing up on the ground thus divested of its former magnificent growth is in strange contrast with the size and grandeur of the dead trunks below them. It consists principally of white birches, poplars and wild cherries. If the theory of alternating growth be true, it would be well if another conflagration would clear the present incumbents from the soil, and allow a new race of pines to begin their growth, and to make good, in the course of years, the loss of their ancestors.

The shores of this lake are low and rocky. The rocks are principally trap rock, broken and strewed in profusion over the surface. Abundant signs of moose, deer and bear were met in our ramble, and occasionally an otter slide was seen on the margin of the lake, but the animals themselves were careful to keep themselves out of our way. Similar rock formation, but not quite so many decaying trunks of heavy pines, were found on the way from Bowlin to Jerry Lake. The westerly shore of this lake was the terminus of our ramble eastward from our camp. Turning to a north-westerly course, we traversed the section between this and "Murch's" (Horseshoe) Lake. About a mile east of the stream, or outlet of this last named lake, (the waters of which pass into Bowlin,) while travelling over a well timbered hard wood ridge, we suddenly came to one of the largest boulders that we ever saw. It stands comparatively alone, isolated, as it were, in the midst of the forest. It is closely surrounded by a thick and heavy growth, while from its top have grown up another forest of stately trees, far overtopping those of the forest around and below them. This boulder is composed of the encrinal or fossiliferous limestone, the site of which we afterwards found further west. We ascertained on measurement that it was 200 feet in circumference. Its walls or sides were nearly perpendicular, though worn and furrowed by the abrasion of water, either before or since its removal from its parent bed. The height was 18 feet, and the area on the top nearly as large as its base and quite level, and was covered with a small wood lot. A soil had, by some means, been formed there, and birches, maples and cedars had sprung up and grown, some of them, to the size of eight and ten inches in diameter. In one of its clefts a family of hedgehogs (*Erethizon dorsatus*) had taken up their residence, but were too snugly ensconced in their "lair" to allow us to reach them. We found that, although a "feeble folk," like the cony of old they had "built their house in the rock," and defied us to dislodge them. So we "left them alone in their glory," and passed on.

Before starting on this expedition, we had received several vague accounts of an island in a lake somewhere in the neighborhood of the Bowlin, in which were sundry galleries and a cave of curious form and construction, "not made with hands."

At the Hunt Farm, Deane Murch gave us a new edition of the story about as indefinite as those we had before heard, and also stated that he had himself, some thirty years ago, when out hunting, seen that same island, and thought he could again find it, and that it was in one of the Bowlin chain of lakes. As he was with us, it was one of the objects, when we arrived at Camp Johnson in No. 5, to make an exploration, and ascertain the truth in regard to the island cave, and fix its location more definitely and certainly, if location it had. On account of the uncertainty of its "whereabouts," we thought it advisable to begin our search at the lower "Bowlin," and proceed upward, exploring the lakes in course until we had found the island, the rock and the cave in question, provided anything of the kind were there. Up to this point of our search we had found nothing that had the most distant indication of anything of the kind, and poor Murch began to think that his sight of the rock he had told us of, was a dream or a delusive vision thrown over him by Pomoola,* on account of some delinquency in his service. We judged, however, that, from the frequent and peculiarly emphatic use of the name of that venerable old demon, and the accompanying unmistakably expressive *anathemas* uttered by him in his disappointment thus far, Pomoola could have no fault to find with him on that score. The discovery of the huge boulder just described confirmed us in the belief of the existence of the island. We concluded that this was one of its fragments, and that, judging from its size, the parent bed could not be far off. It was near night when we had finished our examination. We therefore went on about a half mile to the stream before mentioned, and camped.

Early next morning Louis and Murch were directed to follow up the stream until they came to the lake, while we were engaged at the camp, and to return and report. In the course of a couple of hours Murch returned, announcing, with great glee, that he had found *his lake*, and the island we were in pursuit of—that his character for truth and veracity was fully vindicated, for, strange as it may seem, it was in the very spot where he had seen it thirty years ago. We accordingly went back with him to explore the locality. Leaving the stream, and proceeding in a north-westerly direction over a low ridge of hard wood land, we found an abundance of boulders, and also a ledge of the fossiliferous limestone of the same character of the large boulder just described, and of those found at the Grand Falls, the Hunt Farm, and as low down the river as Whetstone Falls. After a walk of about three-fourths of a mile from our camp, we came to Murch's Lake, usually called, from its shape, Horseshoe Lake. At the westerly end of this lake, and a few rods from the shore, was the long sought for island. The water was sufficiently low to allow of our wading to the spot. It proved to be a portion of the limestone ledge we had just passed, rising up from the water about 20 feet, and say from 200 to 300 feet in circumference. Its top was covered with bushes and small trees. The caves talked about, proved to be large tubes or tunnels from three to four feet in diameter, worn smoothly, as if by running water, in a horizontal position, completely through or across the island. These tunnels are at the base of the island, and, of course when the water in the lake is high, are nearly or quite submerged. They are at right angles to each other. The water was sufficiently low to allow us to creep through them. At the place where they cross each other, is a room, or cavity not quite eight feet in diameter and about five feet in height. There are but two main tunnels or tubes which perforate the island. There are three others commenced, but they pass only a little way before they run into one or the other of the main tunnels. This limerock, as we have before stated, is fossiliferous, and contains several species of organic remains, and the whole of this portion of the lake is floored over, as far as we examined, with the same rock, the flooring being quite level, and is covered with a fine silt or deposit of limestone particles, which render the water turbid when disturbed at the bottom. Here, then, is the site or parent bed of the limestone boulders, which we found scattered along our pathway from Whetstone Falls to the lake. The questions, which an examination of the place gave rise to, are: What has worn these tubes or tunnels through this solid rocky islet? There is no current of waters in the lake, and if it had been done by currents of water, why are they worn at right angles to each other? Was the site of this lake, or this portion of it, once a ridge, or mountain of limestone, which has been carried away by some tremendous sweep of waters and ice, and a basin thus excavated down to the present flooring of the lake, leaving only the lonely island before us as a witness of its former location? These queries and others of similar import can be answered only, if answered at all, by facts obtained by more extended and rigorous observation and research than we were able to make at the time of our visit to the place.

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* The Indian's Devil, who, unless propitiated by special service, was always bringing hunters into trouble.

Having finished our brief examinations, and collected specimens of the rock, we went back to our tent, packed up, and started on our return to Camp Johnson. On our arrival, we met Prof. Hitchcock, who, with Messrs. Goodale and Packard, had gone up the river to Trout Brook Farm, and returned, leaving the others to await our arrival. They had examined the sides and summits of the Traveller and other mountains near by, the rock formations at the outlet of the lakes and its shores, and the next day started again in company with us. Two miles above the camp we came to the dam at the outlet of the Grand Lake (Montagamon). This dam has been built by a company of the proprietors of townships above, and is as firm and durable a structure as could be built of timber. At this place commences the extensive chain of lakes which are found in this section of the wild lands, and which occupy so large a portion of the summit territory between the waters of the Penobscot, Aroostook, Kennebec and St. John. We also find here the commencement of a series of dams and other improvements, built at great expense by the proprietors above named, extending from the foot of this (Grand) lake to the foot of Churchill Lake, at the head of the Alleguash, one of the St. John tributaries, giving them control of the waters of eight or ten large lakes, and extending more than 80 miles. By these dams and one or two locks, they not only husband the waters in these vast reservoirs, but are enabled to bring great quantities of lumber from the St. John waters, which would otherwise have to float down that river instead of running down the Penobscot, as it now does. They are enabled to do this by the slack water caused by the flowage of the several dams, by which immense rafts of lumber are floated across the lakes and through their several connecting thoroughfares. When all the logs of the winter's operations have thus been brought down to the lower dam, the gates are all opened, and the accumulated waters let loose, which gives a freshet sufficient to float them down to the booms above Oldtown, where they are caught and secured for use until they are called for. The thorough structure of these fixtures, and the liberal expenditure over so large an area of country, reflect much honor on the enterprise and energy of the proprietors, and, we doubt not, are found to be profitable investments in a money point of view. At any rate they are instrumental in giving the Penobscot lumberman successful triumphs over the obstacles of nature, hardly rivalled in any other country. We noticed, however, another inevitable result of such flowage. Thousands of acres of splendid interval land, on the banks of the streams flowing into, and the connecting thoroughfares of, these lakes, are submerged a great part of the year. As a natural consequence, the beautiful forest growth, with which they were once covered, is killed, and is falling in every direction. This gives an unpleasant appearance to the otherwise beautiful scenery, and to the eye of an agriculturist seems to be rather a wanton destruction of so much valuable soil. But it belongs to those who flow it, and they have a right to use it in such way and manner as shall give them the most profit.

Between Grand and Second Lake, or as the Indians call them, Montagamon and Montagamonsis, is a wide extent of this now submerged interval land. On the western upland margin of one of these tracts, on Trout Brook, No. 7, in R. 9, the Messrs. Pingree & Co., have made an excellent farm (Trout Brook Farm.) We found this farm under the management of Mr. Berdeen, assisted by three hired men. It is in rather a *retired* situation, being about thirty miles from any other human abode. The soil is excellent and very productive. It is principally devoted to the production of hay, but grain and roots are also raised in abundance. The hay crop, that had just been secured, was estimated at 100 tons. We called here for Messrs. Goodale and Packard, who had made it a stopping place while we were at the Bowlin Lakes, and who had found it an interesting locality for their botanical and entomological excursions, and had enriched their collections with a fine variety of specimens in each department. Learning that the water in the thoroughfare between Second Lake and Webster Lake was very low, it was thought advisable to engage a team of oxen to "*tote*" our "luggage" by land, there being a "supply road" between the two, (ten miles,) the best vehicle of conveyance being a sled. Mr. Berdeen very kindly engaged us a strong team, and Prof. H. having packed up a barrel or two of geological specimens, to be sent out *into the world* by the "first sleighing," we all pushed forward to the head of Second Lake, and camped for the night.

Sledding in August would not seem, to an "outsider," to be the best mode of locomotion, but, bowing to the old adage that "circumstances alter cases," we loaded up the sled with our luggage, placing on top of the whole our batteau, and started forward. The events of the day proved that we had adopted the very best mode of travel which the road allowed. Our canoes were sent up the Webster Stream, with a single man in each. Two men were sent ahead of the team to clear away the windfalls, and see that the bridges were in order to pass over. Mr. Berdeen had furnished us with two yokes of well trained oxen, and a very skilful driver,* who directed the "train" with great care and caution. The road passes through a dense and heavily wooded forest on the route of the Webster Stream. The growth, and the occasional exposure of the earth turned up by the roots of some tree blown over by the winds, indicated a fertile soil of excellent texture and capacity for tillage.

At first the weather was close and sultry, and it was necessary to move very slowly, allowing the team to stop often, lest they should be overcome by the heat, and we left in the middle of the wilderness without the means of escaping. Fortunately for us, a generous shower came up during the forenoon, which not only cleared and cooled the atmosphere, but, by wetting the grass and the leaves in the road, "*greased* the way," and very much facilitated our progress. In this manner, we diligently and patiently "kept on the even tenor of our way," until nightfall, when we came to a place called "Goddard's opening," where we stopped, unloosed the team, and pitched our tents till morning, having travelled six miles. This clearing was made some years ago by Col. Goddard of Portland. Some men had been there a little time previous, and cut and stacked a large amount of hay, from which stores we freely drew fodder for our cattle, and *feather beds* for our men, there being neither barn, hovel nor house on the premises.

In the morning, (August 29,) we overhauled and repacked our load, but, as the stream had become deeper and less rapid, we put in the batteau, with crew to push it forward, and again moved on with our sled and oxen. A little after 12, we arrived at the dam at the foot of Webster Lake, where we found the rest of our party, who had been there some time before us. They had caught a good supply of trout, and killed several partridges, and were preparing dinner in anticipation of our arrival. This was the end of the

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* Charles Buzzell of Clinton.

"carry," and we accordingly dismissed our team and faithful teamster, who had moved us so quietly and carefully over the rough pathway in the forest, that not a single article of our load and apparatus was lost, misplaced or broken.

The dam at the foot of Grand Lake flows back, and makes slack water to this place. Here the proprietors have built another dam, for the purpose of flowing back to the "cut," and husbanding the water for use in spring and early summer in driving their logs.

After dinner we loaded our canoes and batteau, and again embarked for our onward voyage across Webster Lake. This is a very pretty sheet of water about three miles across, and we were not long in arriving at the "cut" at the head of it. On the way Prof. H. stopped to examine the geology of a rocky point which jutted into the lake, where he found some more fossil remains. For years and years, and, for aught we know, ages, this shore, where we had now landed, was considered the extreme point, the "ultima thule," of Penobscot river. Although a short mile from this, another lake is found connecting with a chain of lakes still further on, yet, all waters above and beyond this point were considered *bona fide* tributaries to the St. John, and for the best of reasons, viz., because they ran that way into the St. John, and the portage of a mile across was the boundary between Penobscot and St. John rivers. As soon, however, as the keen-eyed Penobscot lumberman came into this section, the first view of the "lay of the land" convinced him that, if the upper waters had never run this way, they could very easily be made to, and that, by bringing this about, a large and rich country, whether for lumber or other products, would be annexed to the Penobscot valley. More thorough examination disclosed the fact that a ravine, evidently once the bed of a river, extended through from lake to lake, and that there was a moral as well as physical certainty that the waters of the next lakes above (Telos and Chamberlain) once had their natural outlet through this ravine, and thence to the ocean through the Penobscot—that from some cause or other, probably from the collection of windfalls and the washing of the sands, &c. at the shore, this natural channel became obstructed, and the waters, being dammed up here, found their way in a low place in the upper Chamberlain, and flowed thence into the St. John. After a thorough exploration of the ground and the lakes above, a charter was granted and permission given by the Legislature to make a "cut" between the lakes, and turn the water into its original but long arrested channel. This was accordingly done, and done, too, in a thorough and effectual manner. By this operation, Chamberlain Lake now affords the singular case of a lake that has two outlets—one at its northern and one at its southern extremity, and is constantly pouring its waters simultaneously into the Penobscot and into the St. John.

A dam is placed in the cut about forty rods below Lake Telos, by which the flow of water can be regulated for lumbering operations. A very good farm has been cleared here, and a house and barn built for its use. This farm has been neglected for some years past, but has recently been put into cultivation and improvement by Rufus Dwinel, Esq., of Bangor, who had several men here at work. The crops of grain, potatoes, &c., looked well, and the men were engaged felling trees, preparatory to an extension of cultivation. Hay, grain and roots are much used in lumbering operations, and these crops are produced with ease and abundance on the lands that have thus far been divested of the forest, and converted to this purpose, as the soil is well adapted to such productions.

We engaged a team and sled to haul our luggage and boats across from Webster to Telos, and in the morning (August 30) pushed forward. Lake Telos is about five miles across, surrounded with fine swells of land, especially on its southern side. Quite a large tract of land has been cleared on its southern margin, which is used for pasturage for oxen and horses, which have spent a winter's campaign in the lumbering business, and are turned out in the summer to recruit both flesh and strength, preparatory to a renewal of their labors during the coming winter. An examination of some of the ledges on different parts of the shores of this lake led to the discovery of very interesting fossils, and so interested did the professor become in the research, that he hauled up his canoe, and proposed to devote part of the next day in their examination. Arrangements were accordingly made for his bivouac on the clearing just mentioned, during the night, and the remainder of the party pushed forward with a view of reaching the farm on Chamberlain Lake before night. At that place it was agreed to make a stand for a few days, from which we could make excursions to different parts of the adjacent region. From Lake Telos we passed into Round Pond, which is only a part and parcel of Telos, contracted into a smaller circle. From Round Pond we passed through a sluggish thoroughfare, about a mile or more in length, into Chamberlain Lake. This is one of the largest lakes in this section of the country. It is nearly or quite 20 miles in length, stretching in a north-westerly and south-easterly direction, and varies from two to four miles in width. It is capable of accommodating heavier craft than birchen canoes and light batteaux, but none as yet have been launched upon it. Its remote situation from the usual route of civilized life, and the difficulty of access to it, have as yet prevented travel enough over it to warrant the expense of more commodious craft to navigate its waters. The time, however, is not far distant, when those who visit Moosehead in quest of health and pleasure, will be unwilling to return until they have also made a trip to Chamberlain and Telos. As we entered the lake, we found the wind breezing up ahead of us, and it soon became evident that, loaded as we were, it was rather a serious matter how we "*trimmed ship*" so as to pass along safely. Turning to the left, we coasted up the southerly shore to Black Point, where we stopped to bail boat, and "take an observation." The rock formation here indicated that we had passed over the fossiliferous region, and come upon a breccia or conglomerate of slate and old sandstone, apparently fused together. From this point there is a fine view of the "Chamberlain Farm" in the distance on the opposite shore. The cluster of buildings situate on a slope rising gently from the lake, looked like a little seaport in the wilderness. Instead of steering directly for them, the force of the wind compelled our canoemen to steer in another direction, in order to get under the lee of the opposite shore, and even then the spray from these frisky fresh water billows, dashing over the gunwales of our frail birchen cockle shells, made it necessary for us to bail often, lest we should soon have as much water within as without; but we, however, succeeded in reaching our "port" with no other damage than a little wetting of ourselves and cargo. We had letters to Mr. Locke, the foreman of the farm, and were soon domiciled in comfortable quarters. This farm has been established here by Messrs. Pingree & Co., and is conducted on a pretty large scale. Between 200 and 300 acres have been cleared and put into grass. A half a dozen men are constantly employed, and an immense amount of hay, grain and root crops is raised here, and used principally for supplies for men and teams in lumbering in the neighborhood. A large stock of cattle, horses and hogs is also kept on the farm. The crops of grain were then being harvested, teams were ploughing preparatory for another year's crop, and men were also busy in felling trees to enlarge the area of cultivation, and get everything ready for a crop of grain "on a burn" the ensuing spring.

During the next day, Professor H. arrived with his trophies from Lake Telos. He had found a large harvest of fossils, and some of them he exhibited triumphantly as "not being in the books," and therefore new to science. In these days of fratricidal warfare and bloody victories, it may seem small business to feel jubilant over a shell in a rock, and count the discovery of an hitherto unknown mollusk or defunct species of lizard or fish, a triumph; but, after all, there are no victories so really and lastingly beneficial to the world, and so productive of good to the great brotherhood of man, as the sinless and noiseless triumphs of mind over matter, as manifested in the scientific developments of the mysteries of nature.

The time during our sojourn here was profitably spent in an exploration of the shores and waters of the lake, in reference to its geology, botany, entomology and other branches of natural history. Several rare species of birds, plants, insects and geological formations were found here, and preserved for the cabinet, descriptions of most of which are reserved for the final report.

Learning that there would be an opportunity, in a day or two, to send letters and communications to the post office, the nearest of which is *seventy-three miles*, we availed ourselves of the opportunity. The geological and botanical and some other specimens were also packed and forwarded by the same messenger. Having repaired our boats and replenished our supplies, through the kindness of Mr. Locke, our obliging host, on the 4th September we again embarked. Our next direction was up Chamberlain Lake to its outlet, on the north-west shore, and thence down the Eagle, Churchill and other lakes to the Alleguash River, and down that to the St. John. At this outlet is a strongly built dam and a very efficient but simply constructed lock, nsed for the floating logs and rafts of lumber which come up the Eagle and Churchill Lake country into the Chamberlain, to be thence conducted through the lakes and dams we have already passed, and thence down the Penobscot to Bangor. The sides of this lock are the natural banks of the stream, smoothed down a length of several hundred feet, and a dam and gates at the lower end. The lift may be from 8 to 10 feet, though a less elevation of water is often sufficient for its purposes. The thoroughfare from this into Eagle Lake is not very rapid, and the land on either side is rather low, but apparently of good quality, judging from the patches of blue joint and other natural grasses found frequently growing on its margin. As our course was now down stream, we were enabled to make progress with proportionably less labor than before until our entrance into the lake, when we met the wind breezing up ahead of us, and found it necessary to coast along under the lee of some islands, which broke the force of it, and enabled us to make the eastern shore in safely. But soon after noon we were obliged to haul up on "Merrill's Point," and await the passing by of a squall of wind and rain, until near sunset, when, it becoming more calm, we again pushed forward to a landing near the foot of the lake, called the "Merrill Farm." This is a clearing made by a Mr. Merrill, who lived there several years, but a few years ago abandoned it. We found here about 40 acres cleared, the soil a gravelly loam, yielding heavy crops of grass. The crop of this year had not been mown, and that cut last year, consisting of 30 or 40 tons, remained in stack and in barn. A clearing on the opposite side of the lake, of 15 or 20 acres, as far as we could judge in passing by, appeared to be of still better soil, and capable of producing heavier crops than the Merrill place.

Three of our men—Farrar, Hardy and Louis, who had preceded us a day or two to the foot of this lake, with a design to hunt moose and deer, which are generally abundant in this section of the lake country—met us in the morning at this place. Owing to the prevalence of winds and showers, they were unsuccessful, although they came upon the trail of several, but we were not able to wait to give them more time for the chase.

The morning of the 5th was bright and calm, and we made good headway down the remainder of Eagle Lake and through a short thoroughfare into Churchill Lake. These two lakes are nearly of the same size, and, when the water is high, may be considered almost one sheet of water, extending in the length of both nearly 40 miles, and varying in width from two to three miles. On their shores and streams emptying into them are still tracts of good lumber of various kinds, as well as much good soil both of interval and upland. Near the foot of the lake we came to a clearing, occupied by an Irishman by the name of McAfferty, but the premises seemed to be deserted, and his shanty locked. We, however, took the liberty to make a draft upon his potato and turnip patch, which we found to be well stored with an abundant crop. A little below this we came to the great dam. This dam was built by the lumbering company whose dams and cuts and locks we had passed through and passed over from the outlet of Grand or Montagamon Lake to this. This was a heavy and expensive dam, having a lift of nearly 20 feet, and requiring strength to resist an enormous pressure of water, in order to flow back to the lock at the outlet of Chamberlain, not less than 30 miles. It has given away twice since it was built. The last time was about three years since, and is not yet repaired. Measures had been taken to repair it during the present season, and supplies collected at the Chamberlain Farm for that purpose, but the troubles of "secession" and consequent prostration of business prevented. Here we again met with granite boulders, a rock which we had not seen since we left the Grand Falls on the Penobscot. We found it necessary to carry our luggage over a portage of nearly a mile and a half in length, but after lifting our boats around the dam, they were run down the rapids to the end of the portage. We are now in the Alleguash river, and we find the water low and the current swift and strong, and this continued until we reached "Long Lake." This lake is about fourteen miles in length, and from one to two in width. The banks of the Alleguash above this lake are low, and covered with black (evergreen) growth. But very little hard wood growth could be seen. The shores of the lake, however, are higher, and in some parts are fine swells and ridges of mixed growth, indicative of good soil. We had a favorable time in navigating this lake. The weather was calm, and the water very still, affording frequent opportunities for landing on the shores for collecting geological or botanical and other specimens.

About noon of the 6th we arrived at "Cary's Depot," a large farm belonging to the Messrs. Cary of Houlton. This farm is nearly at the foot of an expansion of the river, called Long Lake, on the west shore, and in the line of a "supply road," cut from Ashland to "Seven Islands," in the upper St. John. It is a clearing of one or two hundred acres, well set to grass, and affording large crops of hay and abundance of pasturage for the horses and cattle employed during the winter in lumbering operations in the vicinity. A convenient suite of buildings have been erected, and the establishment makes a very welcome depot for the voyageurs who go up or down the river. We found the soil of good quality and productive. It was under the charge of a Mr. Priestly, a Scotchman, who had in his employ a couple of Madawaska Frenchmen, and who were very busy in felling more trees, preparatory for crops another year. Mr. Priestly received us very hospitably, and gave us such aid as the wants of our expedition required. According to previous arrangement, we divided our forces here, for the purpose of exploring a wider extent of territory. Professor H., with Goodale and Johnson, took an "overland route," (13 miles to Seven Islands, with a view of going up to Baker Lake, the head waters of the St. John, and thence down to Madawaska. Messrs. Packard and Farrar were directed to proceed directly to Fort Kent, and thence into the Eagle Lakes, and down the Machias to Presque Isle. The remainder of the party were to proceed down the river to the mouth of the St. Francis, and up that river to the boundary line. A team and sled was engaged to carry Professor H. and canoe across to Seven Islands, and the rest of us continued our voyage. About eight miles below this, we came to another lake (Pataguomgonsis) nearly three miles in length, which is a very fine sheet of water, and the last of the Alleguash series of lakes. After leaving this lake, we found the river low and rocky, the men having sometimes to get out and drag the boats over shoal places, causing considerable detention and delay in our progress.

About 20 miles below Cary's depot, we came to the Monroe Farm. This is a fine clearing and farm on the Ingersoll township, (No. 15, in the 11th,) owned by a Mr. Monroe, a Scotchman, who has been here twelve years, and by his industry and perseverance has made him an excellent farm and has put up good buildings. We counted sixteen head of cattle in his pasture, together with ten hogs by way of gleaners to the neat stock. He also had a gang of men reaping a fine crop of wheat, which was a very good one, the straw being bright and strong, and the berry plump. Owing to the prevalence of wet weather in the spring, this wheat, he informed us, was sown late, and consequently the harvest, (September 7th,) was also late. Among other appendages to the farm, we found a large kitchen garden, well filled with roots and cabbages, and also a patch of Indian corn, but he said he had not succeeded in ripening this crop. The staple crop with him is grass, the hay from which has hitherto found a ready sale at good prices to lumbermen, as have also all the crops he could raise, especially oats, which were always in good demand. We were much pleased with the evidences of thrift and good management manifested about the farm, and we soon accounted for the causes of it when we heard the cheerful song of his wife in the house, who was lightening her domestic cares and labors by trilling a Scotch air to the household. Since we left the Hunt Farm, we had heard no female voice. The few farms where we had stopped thus far on our way had all been carried on solely by *man power*. Not a woman was to be seen to assist in health or solace in sickness. It is true the common routine of domestic life were conducted there passably well. Men can live thus isolated from all social ties, but it is a sort of Robinson Crusoe life after all, administering more to the mere necessities than to the comforts and rational pleasures of existence. Something more is wanting than shelter and victuals and drink. God himself saw that even Paradise was not complete, until he had given to Adam his finishing touch of creation, a loving wife.

Three miles below Monroe's we came to the Alleguash Falls. This is quite a formidable pitch of water, which tumbles down a ledge of slate rock in several cascades, which will some day afford valuable mill sites to the settler. The "portage" around these falls is about a half a mile, and a very comfortable one, the lumbermen having bushed out and smoothed the pathway so as to make it easily travelled. The water below the falls was found to be low and difficult. Three or four miles below we pass another slate ledge, containing limestone and some calcareous spar. Nodules and small boulders of similar calciferous slates were found at the mouth of the Kekobscus, a considerable stream, which comes in here from the east. Possibly an exploration up this stream would lead to the discovery of a greater supply of limestone.

Contrary to what we usually found in rivers, the nearer we approached the mouth of the Alleguash, the shoaler the water became, and we found it necessary often to get out and wade, in order to lighten our canoe and batteau, to get them over the bars and shoals that obstructed our progress.

On the morning of the 9th, (having remained in camp Sunday, the 8th,) we found ourselves once more within the borders of civilized life, and landed at the Bolton Farm, at the mouth of the river. This farm is owned by Samuel Bolton, formerly of Augusta, in Kennebec County. It is situate in the forks of the rivers St. John and Alleguash, and is an excellent tract, principally of alluvial soil, and very productive. He has been here eighteen years—has been very successful in his farm labors—has furnished himself with good farm buildings, and was engaged at the time in building a large and commodious barn for storing his increasing crops of hay. Wheat, barley, oats and roots and hay are his staple products. He has raised Indian corn, but as the other products are so much easier raised, and more in demand, he cultivates them exclusively. The sales of his surplus produce last year amounted to $900. Our course now turned easterly. We found the St. John waters nearly as low as those of the Alleguash for some distance, but it gradually grew deeper, and afforded us better boating. A passage of twelve miles brought us to the mouth of the St. Francis, which comes in from the north, and is one of the principal tributaries of the St. John, its source being some 75 miles further north, in the province of Canada East. From the mouth of the Alleguash to the mouth of the St. Francis, the St. John passes through a deep valley or gorge, formed by a lofty ridge of hills on either side, skirted at their base by a narrow strip of interval between them and the river on each side. Sometimes these hills come quite down to the river's bank, leaving a margin sufficient only for roading.

The rocks are "calciferous slate," but none of them form any obstructions to the river, which flows onward with a strong and steady current, excepting an occasional rapid not very difficult to navigate. Below the St. Francis the margin of interval widens, and the hills in the rear are not so steep. At the mouth are a few islands, some two or three of which are excellent for grass, being overflowed sometimes in spring, which causes them to bear every year heavy burthens, and the interval opposite is also exceedingly productive. Mr. Savage, whose farm comprises a portion of this interval, and also two of the islands, stated to us that he cut two hundred tons of hay last year.

Leaving part of our supplies and other luggage at Mr. Mellows', who very kindly took charge of them, on the 10th we turned our course northerly up the St. Francis. This river is of some geographical consequence, as being the boundary between three separate governments. Its west bank is in the State of Maine, and therefore a part of the boundary of the United States. Its eastern bank, to the foot of Beau Lake, is the boundary of New Brunswick, and above that point it is the boundary of Canada East. For the first ten miles we find the shores of this river possessing characteristics similar to those of the St. John. The rock formations are the same calciferous slate—the hills, on either side, rise high, with a narrow belt of interval occasionally between them and the river. We noticed, however, that the soil of the intervals was of lighter texture, being more sandy than most of those passed on the St. John. This river is also deep and not very rapid. Indeed, it may be considered as being made up, in great part of its route, by expansions into lakes, some of which are quite respectable in size and depth. It is about 40 miles in length from its mouth to the monument on Boundary Lake, and is navigable for horse tow boats up to "Kelly Rapids," or about 30 miles. The two principal lakes are Glazier Lake and Beau Lake. The latter is about six miles in length and two broad, its upper terminus about twenty miles from the St. John. Above this lake the hills recede, and are less in height, and the alluvial or interval lands are broader. Just above Beau Lake, a Mr. Morrison has cleared a beautiful tract of interval, and is making an extensive farm, and rearing up a young family, twenty miles from a single neighbor. They manifest commendable patience and contentment in their situation, and cheer themselves with the hope and expectation that the Canadian government, to which province they belong, will soon make a road through to the St. John settlements, and open the territory for sale to pioneers. It would certainly be for the interest of that government as well as ours so to do, for the lands are of good quality, and a road on the margin of the river, from the bridge at the upper extremity of Boundary Lake to St. John, would open a new and shorter thoroughfare from the Aroostook towns, by the way of Fort Kent, than any other. Above Morrison's, the river, though keeping its general direction, is nevertheless very serpentine, abounding in short crooks or turns. The banks are high and sandy, the sand being made up principally of abraded slate. In consequence of the frequent windings of the river, these sandy banks are constantly shifting their form and position. The growth on these sands is mostly composed of the Canadian poplar, or balm o Gilead, (*Populus Canadensis.*)

At Kelly Rapids, which are about two miles in length, we met with boulders of slate and white limestone, but we saw no rocks in place in the upper St. Francis, until we came within four miles of the monument, when we met with a ledge of slate and limestone, cropping out on the Canada side.

We were detained a part of a day by rainy weather, but arrived at the monument* on the forenoon of the third day of our voyage up. The same characteristics of soil and growth as was found below, also predominate on the shores of the lake, but further back from the water are good tracts of pine and hard wood. While in camp here, Hardy and Louis went out in the evening, and speared a lot of white fish, which at this time were quite abundant in these waters. We have seen specimens of this same fish (*Coregonus albus?*) caught in the Madawaska Eagle Lakes, at the head of Fish River, and at certain seasons of the year quite a business is made by the Madawaska people in catching and curing them.

Having made what observations we could at this point, and collected such specimens of rock, bird, fish, and other objects of natural history, as we met with, on the 14th we turned our prows about, and retraced our way down stream. The current, and the wind, and the weather, were all favorable, and the next day we landed again at Mellows', on the St. John, where we camped for the night.

Here ended the principal examination of the wild lands for this season. The facts that were ascertained on the route afforded us both satisfaction and regret;—satisfaction with regard to the developments which we have been able to make of the fertility of the soil—the abundance of water power for various purposes in the future—the discoveries in economic and scientific geology—the collections illustrating our natural history, and the observations of the agricultural capabilities which now lie slumbering throughout the territory passed over;—regret, that this fine country should not have been retained in the hands of the State, instead of having been sold to individual proprietors. A misapprehension, or rather an ignorance of its real value, induced what, with deference, we consider to have been a very mistaken policy with our government. The idea has prevailed, that all these lands were suitable only for lumbering purposes—that they constituted a vast "pinery," valuable only for the production of timber, and little else. Hence, every township drained by the Penobscot, we believe, has been suffered to pass out of the possession of the State into that of proprietors. They, as is very natural, hold it for the purposes for which they bought, and are anxious to keep it in a wild condition, productive only of the growth and yield of different kinds of lumber. Had the State retained these lands, and opened roads, and given facilities to settlers as it has in Aroostook, a very different condition of things would long ere this have existed there. Here is a healthy and naturally fertile territory, capable of supporting, at a very moderate computation, 150,000 inhabitants,* completely shut up from settlement, and occupied at present by only about *forty persons.*

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* This monument is a heavy obelisk of cast iron, placed there by the commissioners of the boundary survey, in 1852. It stands on the most northerly point of Maine.

We will not dwell upon this subject here, but we trust no offence will be given, if we express our firm conviction that, if a different policy had been pursued in regard to our public domain in this, the very central portion of the State, many sections of these solitary wilds, where the "bear roams, and the wildcat prowls," would long since have yielded to the woodman's axe, and the silence that now broods over them given way to the hum of cheerful labor and productive industry.

An earlier survey of this kind would have led to a very different state of things, and been repaid in a tenfold ratio. That this is not an idle and visionary fancy, is abundantly proved by the history of the Aroostook. The survey and exploration of that region nearly thirty years ago, led to a true knowledge of its value, and to a settlement of the boundary troubles. There were then only about a dozen families on the whole length of the Aroostook River. The liberal policy in regard to the lands, led to their settlement, and the contrast between the true importance and practical utility of the present "status" of the two regions is singularly striking. They both lie in the same range of latitude, but, in addition to the increased and increasing taxable value of property in the Aroostook, thereby contributing to the strength of the State, and promoting public prosperity, your call for aid in the hour of the nation's peril is answered with a shout and a bound from thousands of her robust and stalwart sons, who, rushing to the rescue, swell the heavy battalions of your army, and proffer their fortunes, their strength, and their lives for their country's salvation. Call upon the neglected wilds of the upper Penobscot, and the answer would be an empty echo. Is not the true value and reward of liberal State policy well demonstrated in this?

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* The waters of the Penobscot, St. John and St. Francis, the main channels of which we traversed, drain, say 100 townships, or 2,400,000 acres of land. Allowing to these townships only 1500 inhabitants as an average, and you have 150,000. Or, take another view, and allow only one person to every 25 acres, and you have 96,000.

The next morning (16th) we reloaded our boats, and started, "homeward bound," down the St. John. During our absence up the St. Francis, Professor H. and party, who had found the river so low as to prevent his reaching "Baker Lake," turned about, and had passed by, leaving a request that we should meet him at Woodstock, the route that way being the most feasible for our return. Accordingly, we pushed along as fast as strong and willing hands and a lively current would propel us, and arrived there on the noon of the 19th.

At Fort Kent, we stopped a short time to exchange greetings with some old friends, and to receive letters and papers directed to that office for our party, and which were indeed necessary to "post us up" with the world. For nearly two months we had had no communications from the world without. We had literally enjoyed what Cowper so devoutly prayed for—

——"a lodge in some vast wilderness,
Some boundless contiguity of shade,
Where rumors of oppression and deceit,
Of unsuccessful or successful war,
Might never reach me more."

As if to make the contrast complete, on our approach to the village the stars and stripes were almost the first object that met our gaze, as it spread its folds to the breeze, and the exciting strains of martial music saluted our ears. On landing, we found that a company of hardy pioneers had, through the influence of Mr. Stevens, the active host of the Fort Kent House, volunteered for the service of their country, and were preparing to leave for the Potomac.

A voyage down the St. John is an interesting one. We had not time, however, to make all the observations and inquiries, and to note all the peculiarities of scenery, and soil, and agricultural condition, that presented. One thing, however, was very evidently lacking along the settlements we passed. There is not that variety of manufactures among them that there should be. Lumbering has for years and years been their leading and all-absorbing business—cultivating their land the next, but this has been secondary and subordinate to the first. These two pursuits have given the people a living, and many have thereby accumulated considerable wealth, but when lumbering comes to a stand-still, they all stand still.

We noticed that the "intervals" on either side of the river, especially between the Little Madawaska and the Grand Falls, are broader and more fertile than those higher up. These are occupied principally by the descendants of the French Acadians, who settled upon them at an early day, and they seem perfectly contented to practice the simple habits and customs of their fathers, little troubling themselves with the progress of improvements in any of the industrial arts.

Agricultural Adaptation of the Wild Lands Explored.

The Penobscot, passing in its general direction from a northerly to a southern point, through an extent of 2½ deg. of latitude, and in that course also rising to quite an elevation from the sea, must exhibit, in various sections of its course, a considerable range of climatic difference, and, consequently, of agricultural capability. The first question usually asked by a farmer, when wishing to ascertain the agricultural character of any northern location, is—"Can you raise Indian corn there?" This crop seems, by common consent, to be the criterion by which to judge of the climate and its agricultural value.

We find that the line which bounds the northern limit of Indian corn maturing in Maine, is a very irregular one, as, indeed, might be expected, coinciding, as it does, with the isothermal line, and not with the line of latitude. We find that the elevated or mountain district,—which, as we have in a former part of our report mentioned, formed a part of a triangular belt, having its base on the western border of the State, south and north of Umbagog, and stretching easterly to its apex in Mars-hill,—is not a sure corn maturing region. Corn can be raised with certainty within a few miles south of Umbagog. It is raised with less certainty on the lake shores, and again with more certainty on the northern side, as the slope sinks down toward the shores of the St. Lawrence. The Penobscot extends into this belt, and hence, while in its lower sections corn is a safe and profitable crop, in its upper section we find it a precarious one; while further east, on the same line of latitude, it is again found more certain.

At the Trout Brook Farm, we found two parcels of corn growing—one of them (27th August) nipped by frost, while the other, on a more elevated piece of land, was not touched. At Monroe's farm, on the Alleguash, we found, as we have before stated, a small patch, which had not been frosted, but were told by Mr. Monroe that he had not been able to mature it. Still further north, Mr. Bolton, who, as we stated, has a fine farm at the confluence of the Alleguash and St. John, informed us that he had some years raised as good corn as ever he had raised in Augusta, (his native place,) although it was not a sure crop. Some have attributed this trouble to difference of soil, but it is more attributable to mountain and lake influences on the temperature, as well as to the fact that, owing to the immense extent of the forest, the earth, for a great breadth of territory, is kept cool and moist. The sun cannot penetrate among the leaves and branches of the trees to warm the soil to any great extent. Hence it is fair to infer that the climate, in this respect, will be materially changed, should the country become cleared. The experience of "old settlers," we believe, will corroborate this, and, therefore, although there will probably always be a tract of country where corn will be uncertain and unprofitable of culture, we may predict that this anti-corn locality will be much reduced in extent by the clearing up of the land, and opening it to the sun and the warm southern breezes.

Wheat. The soil over which we passed is as a general thing well adapted to wheat growing, and the climate is also favorable. The first crops on burns, is generally heavy and remunerating, but after a year or two, the natural enemies of this valuable crop begin to multiply as on the older farms, sometimes making such inroads as to reduce the profits very materially. Hence, not so much wheat is raised where there have been clearings, as there is of some of the other cereals. In one or two instances, on the St. John we saw very fine fields of wheat growing in healthy luxuriance in isolated clearings on top of high hills, where a "chopping" had been made in the forest and burned off for this very purpose, of wheat growing. The reasons given for growing wheat in such out of the way places, was the fact that the midge and the fly and aphis would not find the spot for several years, and the crop would not suffer from their depredations. Still wheat is not so much cultivated as one would suppose it would be, because the other grains, such as oats and barley, are more productive—are more in demand by the lumbermen, and bring in proportion to the cost of raising a larger and more remunerating price per bushel.

Oats and Barley are therefore the principal grain crops grown. These grow vigorously on the new lands—have but few enemies to contend with—often produce enormous crops, and sell readily at large prices.

Buckwheat. This will grow almost spontaneously on these lands. It is a staple crop among the French, or Acadian settlers. The rough variety, or "Indian wheat," as it is sometimes called, is the only kind cultivated. It is a sure crop—yields large amounts to the acre—easily gathered and cleansed, and is much used by them as an article of diet and for fattening their hogs and poultry. It may be a matter of fancy on our part, but we thought we could see some connection between the physical energy of the farmers in that section and the crops that they raise. There was an apparent listlessness and lack of physical stamina in those Acadians who cultivated little else than buckwheat for bread, compared with those who paid attention to the culture of the wheat and other cereals. Whether the buckwheat diet was the cause, and the debility the effect, or vice versa, we will not here attempt to decide. The flour or meal from this grain is much used by the settlers for fattening pork, and some of the fattest hogs we ever saw were fed principally upon buckwheat gruel.

Root Crops. The various esculent roots, such as potatoes, turnips, ruta bagas, parsnips, carrots, beets in all their varieties, onions, &c., are "at home," throughout the whole extent of the region we traversed. Any amount of them can be produced, and would be produced for export, did the facilities of transportation warrant their being carried to market at a reasonable expense. Not only is the crop generally large in quantity, but excellent in quality.

Small Fruits. Most of the small fruits grow luxuriantly in this section of the country, and their cultivation would be eminently successful. Strawberries, currants, gooseberries, blackberries, blueberries, are all indigenous to these lands. The wild currants, however, are not so palatable as some others, but the fact of their being native to the land is proof that the improved and cultivated varieties will find congenial soil and climate. Cherries and plums will also flourish well, though we could not promise that the

"Black-knot" would let them alone. This singular disorder is by no means confined to civilized life. It was frequently met with far away in the forest, thirty or forty miles from any gardens of cultivated fruits—fastening itself upon the wild cherry trees and disfiguring and blighting them as severely as any ever seen in the gardens in the oldest sections of the country.

The "high or bush cranberry," (*Virburnum opulus,*) and the common lowland cranberry, (*Vaccinium Oxycoccus,*) are found abundantly, the first by the side of streams and swampy lands and the latter on the wet meadows and bogs.

Stock Raising. The wild lands which we examined, are capable of making an excellent stock growing country when cleared and laid down to grass. It is true that the length of the winters and the consequent longer time required to feed from the crib serve in the minds of some as a drawback, but there is a compensating principle in the superior advantages for grass and hay during the summer season, brought about in part, by the covering shelter of the snow which protects the earth and the herbage, until the season is too far advanced for any injury to arise from too much freezing and thawing, during the transition from winter to summer. If it were not for the losses often occasioned by wolves and other wild animals, the Upper Madawaska section might grow almost unlimited amount of wool and mutton. The rich intervals and upland, so well adapted for forage crops, would yield ample supply for winter feeding, and the cool and breezy slopes and tops of their hills would give the best of pasturage for them. It is to be hoped that in time, this important branch of husbandry will receive more attention in that part of the State, and their flocks increased as fast as is compatible with safety in the investment from beasts of prey.

The abundance of pasturage and the good condition of the cattle and horses on the few clearings now to be found along the route we travelled, is a practical demonstration that such stock may be advantageously raised in those townships as soon as the forest can be changed into a grass growing field, and that can be done in two years from falling and burning the trees.

NATURAL HISTORY OF WILD LANDS.

Although our exploration of the wild lands occupied but a part of the season, and embraced a small portion only of that section of the State so designated, our researches in reference to its Natural

History were attended with good success, so far as the collection of specimens for the cabinet and fixing or making certain of localities were concerned.

Many important facts were obtained, which are reserved for the future, when they, with such additions as future explorations may give, will be elaborated and published in the final report. The birds and quadrupeds which make these wilds their "habitat," are included in the catalogue given in a former part of this report. The accompanying reports of Messrs. Goodale and Packard, will give valuable information in regard to the Botany and Entomology of the region passed over. A collection of such fishes and reptiles as we met with was also made, and is preserved in the cabinet, and description reserved for final report. In these two last named departments, as well as in the others, researches should be made in the earlier as well as the later parts of the season, as they have their regular times for appearance and disappearance, as well as birds, insects and plants. More explorations in different months as successful as that just accomplished, will enable us to furnish a pretty full report of all departments, and give a Natural History of Maine that shall be true to the types nature has given, and as complete as the discoveries made shall allow.

Physical Geography of the Penobscot River.

It might be expected that a report upon the Physical Geography of the Penobscot should accompany this report. This was intended; but the voyage up to the source of its main channel, convinces us that this should not be attempted until a full and thorough exploration shall have been made of all its tributaries and collateral branches.

A river of this magnitude,—extending through so wide a range of country, and ramifying through such a diversity of soil and geological formation,—through sections long since cleared and highly cultivated,—through dense forest still clothed with the primeval growth,—through sphagnous swamps and mountain gorges,—must be rather varied in its Physical characteristics. The notes and observations thus far made on this branch of the survey, are reserved until more extensive observations shall render them more complete, some conjectural points be rendered more certain, and doubts confirmed or removed.

BOTANICAL NOTES ON THE NEW LANDS.

To Ezekiel Holmes, *M. D.*,
Naturalist to the Scientific Survey:

The tour in the wild lands of the Penobscot and St. John rivers, was commenced at a season peculiarly favorable for botanical investigation. The plants which had flowered in early summer were found in fruit, and the Compositæ of autumn were just in flower. This enabled me to examine two entirely different sets of plants and under advantageous circumstances. Of course the investigations were mostly confined to the immediate neighborhood of the larger rivers and more important lakes.

It is not deemed necessary to give, in this report, any detailed sketch of the journey; but rather to present an account of the vegetation observed in the various sections of the route. The division of the route into floral sections is not so arbitrary as might, at first, appear; on the contrary, the limits are in every case well marked by the appearance or disappearance of one or more important plants.

The first section extends from Bangor to the Wassataquoik river near Katahdin; the second includes the lands between the Wassataquoik and Seboois rivers; the third embraces the territory between the Seboois river and Churchill Lake; the fourth extends as far as the Long Lake on the Alleguash; the fifth comprising all the lands as far as the northern boundary of the State.

The vegetation changes very little for the first twenty miles above Bangor. The first change of any importance is the substitution of a species of Zizania for the smaller pond-weeds noticed near the shore at Oldtown. This species of wild rice is evidently distinct from Z. aquatica, *L.* as the leaves are longer but narrower; and the paleæ awnless. It is very near Z. fluitans of Lower Florida. This is the most characteristic water weed of the Penobscot till we reach Medway where it entirely disappears, and its place is taken by Glyceria fluitans or Floating Rattlesnake grass.

The timber along the shore as far north as Medway, has been thinned out by the lumbermen, and very little first class lumber now remains near the banks of the river. The vegetation of the vicinity of Medway may be called the same as that of northern Oxford county, and a glance at the map will at once show that they are on nearly the same parallel. Above the branching of the Penobscot we find certain plants not detected by us lower down the river, except as very rare. Here we find in great abundance, Lobelia Kalmii, Anemone Pennsylvanica, and, more rarely, Aralia quinquefolia. This marked vegetation continues to be noticed as far as a point on the river, thirty miles above *Nicatou*.

Wassataquoik Section.

At the mouth of the Wassataquoik, is indicated a fertility not seen lower down on the river. In fact, certain plants are found only a mile from the house occupied by Mr. Hunt, growing to an astonishing height and in every way indicating an exceedingly fertile soil. Wild Lettuce was seen, with its topmost flowers, as yet undeveloped, at a height of eleven and twelve feet from the ground; leaves of the Elm, measuring seven inches in length by five in width; Blue joint grass with its loose spike seven and eight feet high. And the whole interval seemed to be equally rich in its vegetation, affording a superior soil for the farmer. Indeed the vegetation of this section is very remarkable and resembles in great measure that of the singular tract of fertile land in Aroostook county. The crops being raised by Mr. Hunt, at this place, were flourishing finely and proved that even by superficial cultivation the land would yield abundant crops.

Mt. Katahdin is distant from this point of junction of the Wassataquoik and east branch of the Penobscot, twenty-five miles. Upon our route over the first ten miles of the way, we all had frequent occasion to complain of the great height of Blue joint grass which was often seen taller than our heads. It was at this part of our journey that we saw the only specimens of Halenia deflexa, *Grieseb.*, noticed during the tour; and this leads me to think that its range in Maine is somewhat limited, being confined to the vicinity of Katahdin and one or two other mountains of considerable elevation. Good timber is not remarkably abundant in this region, the Pines and other cone-bearing trees decreasing in size and number as we approach the base of the mountain.

Katahdin itself does not present any botanical features distinct from those of the same altitude as Mt. Washington; we find the same disappearance of Solidago thyrsoidea, *Meyer*, as we ascend, the introduction of the mountain berries and willows at nearly the same elevation at which we find the identical plants at Mt. Washington. Indeed, botanical investigation has failed as yet to detect on Katahdin any plants unknown to the higher mountains of the United States, with the single exception of Saxifraga rivularis, *L.*, var. comosa. This brilliant discovery rewards the long continued searches of one of our most acute American botanists, Rev. Mr. Blake, formerly of this State and now of Gilmanton, New Hampshire. The summit of Katahdin is clothed with the common lichens Cladonia and Lecidea. Very few Parmelias were seen on any part of the most elevated portion.

The "basin" or crater of the mountain (for it must be remembered that Katahdin resembles the crater of an extinct volcano) exhibits many of the White Mt. plants which I have never seen accredited to Maine. These were Epilobium alpinum, Viburnum pauciflorum, Ribes rubrum, Aspidium aculeatum, var. Braunii, &c. The thickets of Black Spruce in this basin are very dense, and render walking hardly a matter of pleasure.

The timber on the Penobscot near the Wassataquoik has been thoroughly explored by lumbermen, and the best of it has long ago been sent down river. But a good deal yet remains to be cut, and upon soil which will amply remunerate one for cultivating. The land at this point will be for settlers, when it is once opened by roads, as desirable as any new farming land in the State.

Seboois Section.

This division comprises the lands which have in part been burnt over in 1825, and present at this time principally second growth. The pine and spruce timber in this section is small and not very abundant, and the same is said to be true of all the cone-bearing trees in the Seboois valley. How far this is true of timber at any great distance above the mouth of the Seboois I am not prepared to say, but it is most assuredly the case upon the Penobscot in this vicinity. The second growth trees, the birches, poplars and occasional maples are everywhere a noticeable part of the vegetation, while Iron-wood, Hop-Hornbeam, White and Black Ash occur more infrequently. The smaller shrubs and herbs observed in this part of the course of the river were principally, those characterizing the flora of the vicinity of Bangor with the addition of Epilobium angustifolium and E. coloratum, which grew very abundantly. These two plants are called by the lumbermen on the river, "Burnt-weed," "Fire-weed," and "Fire-top," but the more common fire-weed of Massachusetts was unnoticed. One specimen of Erechthites hieracifolia, which usually receives the name of Fire-weed, was all that we were able to obtain on the tour of several hundred miles! Passing northward we leave the burnt land and come upon a section strikingly different. Herbs are of smaller size, especially the Asters, than those of the lower land just left behind. This division is called for convenience, the

Grand Lake Section,

and comprises the land between a point ten miles above the Seboois and Lake Telos. The timber on this section is quite good, and though large trees are less abundant than they formerly were, still enough remain to give one the impression that these are the best forests yet seen on the route from Bangor. Upon a mountain called the "Traveller," near the river, I was able to see for the first time in its live state, that remarkable Conifer, Pinus Banksiana or the Gray pine of Michaux. It was a stunted tree of a singularly stooping and spreading aspect. Many of the trees, not more than five feet in height, would cover with their branches a circle eleven feet in diameter. Under this pine we collected, late in August, fine blueberries which I have never seen exceeded in size or excelled in delicacy of flavor; and still more abundantly the "rock cranberry" or Vaccinium Vitis-Idæa, Empetrum nigrum, and Arctostaphylos alpina.

At the base of the mountain I was so fortunate as to discover the rare Hippuris vulgaris growing abundantly in a bog and near it was Arnica mollis commonly recognized as a mountain plant. The northern Gray pine was not seen again till we reached an island in Matagamon or Grand Lake. Here I found it was abundant, and was informed by an experienced lumberman attached to our party, that this "Shore pine" or "Rock pine" occurs very rarely in the forests of the State—and this one place in Grand Lake was the only locality of the pine known to him. Others have since told me the same, so I think it is plain that its range in Maine, like that of Halenia is quite limited. In this Grand lake section we had the pleasure of examining a large and well conducted farm, and seeing what weeds troubled farmers sixty miles from any village. To my surprise, very many of the weeds rarest on farms in the southern, middle and western parts of the State were common at this farm. Rudbeckia hirta which had been probably introduced very lately with hay seed or seed of some other crop—Ambrosia trifida, Trifolium procumbens were noticed and many others which it is needless to mention. In a swamp near the farm I observed a good deal of Nardosmia palmata, the fruit of Calypso borealis and Arethusa bulbosa. These highly interesting species occurred in such plenty as to lead one to think that a botanical visit earlier in the season would be repaid by a very choice collection and the discovery, perhaps, of some plants new to the State.

The timber of this section must be more carefully described. A great deal of fine timber in this vicinity is as yet uncut, although not a square mile of land can be found in it where some lumberman has not gone. The "Juniper" here is of free growth and affords a large proportion of the Juniper knees which are so rapidly supplanting other kinds of timber in our ship yards. The "Juniper," so called by the lumberman, is always identical with the *Hackmatac* of lower Penobscot and the Larix Americana of Linnæus. The spruce is also of good quality and abundant. At Lake Telos we arrive at the southern limit of a new division which may be called the

Alleguash Section.

It embraces the land lying on the great lakes and the southern part of the Alleguash. That around the lakes is distinguished by Juncus militaris, Potentilla fruticosa and Rumex salicifolius which here appear for the first time in abundance. The timber on Chamberlain and Eagle Lakes does not differ much from that on Lakes Telos and Webster. But as we approach the head of Churchill Lake we notice larger trees in greater number. Of course this is owing in a measure to the fact that lumbering in the vicinity has to be carried on at a disadvantage and the heavier trees have not yet been floated out. This timber on the Alleguash was said by all our party to be the finest on the route—in fact while passing down the river this was a theme of frequent remark.

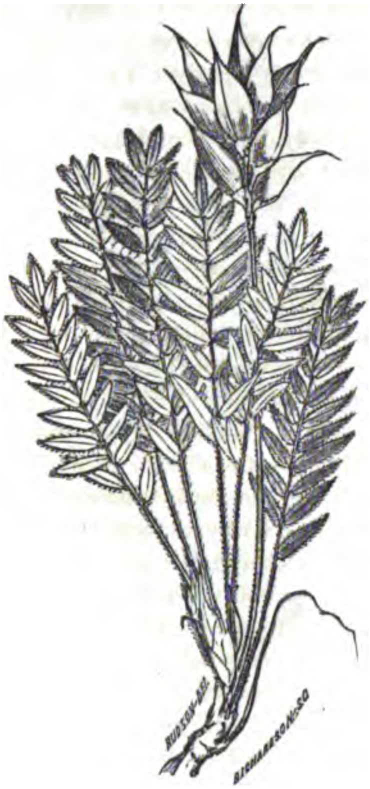
A glance at a map of the United States will show that the north of Maine is on nearly the same parallel as a portion of Lake Superior, and so by analogy we might be led to find some western plants in northern Aroostook. This proves to be the case. Even a casual survey, rendered more hurried by the approach of the autumn drouth which would render the navigation of the St. John very difficult and tedious, enabled me to identify many Lake Huron and Superior plants on our upper boundary. The main river was explored as far south as township eleven. Here the shallow water prevented us from going up river any further, while the rapid falling of the water warned us to make our journey to Fort Kent a rapid one. From township eleven, therefore, the description of the plants of this district may commence. At this point the timber is not remarkably good; the pines being of small size and neither clear nor straight. Spruce was some better and well pays for extensive lumber operations above Seven Isles. Few hard wood trees are to be seen in this part of the country. Along the shore we find Tofieldia glutinosa which grows for the most part on a wet soil, especially on wet ledges and disintegrating slates. With it, occur Anemone parviflora and Nabalus racemosus. The latter plant is noticeable for its glandular involucres and its very smooth radical leaves. This plant was seen frequently till we left the main river at Woodstock, in the Province of New Brunswick.

A singular species of Lathyrus was noticed near Black river, but specimens were too mature to admit of proper determination. With this Lathyrus was also found a plant which subsequent investigation has proved to be an Oxytropis. Dr. Gray, to whom I am much indebted for many acts of kindness, says in a letter of November 7th, "This seems to be near O. Lamberti, var. d., *Tor. and Gray*. However, I have a fancy that it may be O. Uralensis."

Astragalus alpinus, *L.*, occurs plentifully along the banks of the river from this point to Grand Falls; flowers seems sufficiently distinct from A. Robbinsii, *Gray*, which grows by its side.

I found Artemisia Canadensis growing sparingly on slate rocks near Madawaska river, and afterwards at Grand Falls. Common mugwort, a plant of the same genus, and a very vexatious weed, grows abundantly with it. What law of selection places these kindred plants together, the one an introduced weed and the other an indigenous species? If the same fact had not been noticed at both points where A. Canadensis occurred, it would not have been thought worthy of even a passing remark.

One of the most attractive plants in this district is the Huronian Tansy which I am able to add to the list of plants new to New England. It grows in patches of three or four feet square, and everywhere presents the same soft and finely dissected foliage. The odor is not so pungent as that of common garden tansy; it is rather like that of *yarrow.* A plant so characteristic, of north-western vegetation, detected at a point so far east and in such plenty, suggests that a more careful survey of the section will develop many highly interesting facts. Specimens of this plant could be obtained only in fruit, but even then it was apparent that it would be a desirable plant for our flower gardens. The cut unfortunately does not represent that which forms the greatest beauty of the plant—namely, the long and silky pinnatifid leaf.


BURGESS DEL.
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OXYTROPIS URALENSIS, DC.

Near Grand Falls on the St. John, a grass was detected which proves to be Vilfa cuspidata, *Tor. in Hooker, Fl. Bor. Am.* It is a delicate grass, with a filiform leaf and short, slender spike. The species is thus brought south and east of the locality at Saskatchawan.

From this brief and hurried account of the indigenous species of the St. John's section, I proceed to speak of the more important cultivated plants peculiar to the region. So far as I have been informed, the Acadians on the St. John are the only people in America who use certain of these plants to any great extent, although the same species have been cultivated for a long time in some parts of Europe.

TANACETUM HURONENSE, *Nutt.*

It may be proper to say, in this connection, that the Acadians are descendants of people who emigrated from France in the last century, and they still preserve many of their former French customs and habits. And so we find growing in their gardens and fields the same species which were cultivated by their ancestors who brought the seed from Europe. Among these plants the most important are the Alliaceous or Garlic tribe. Not only do the Acadians cultivate the common onion which is Allium Cepa, and the garlic, Allium sativum, but also the following which are commonly recognized as belonging to the south of Europe:

Allium pallens, *L.*—A stout plant with tubular leaves and drooping flowers, in which the stamens are as long as the corolla.

Allium Moly, *L.*—Leaves all radical, flat and sessile; umbel branching; flowers large and yellow.

Allium Cepa, *L.*, var. a.—Bulblets underground.

These plants are used extensively by the Acadians in preparing the buckwheat and barley broth upon which they subsist. They even use garlic in their bread, or at least that is the impression a stranger receives. Barley is one of their principal crops, and can be raised with certainty. Rye is cultivated to some extent, but the great staple is "Rough Buckwheat," or, as they call it, "Sarrazin." This is the true Polygonum Tataricum of the European botanies, and differs from common buckwheat not only in the slender cotyledons, but in the roughness of the seeds.

The fact of its early ripeness is of vast importance to people who live where a frost in August, or early in September, is not uncommon. But this is not the only reason of its extensive use among this people. It seems most likely that buckwheat is planted and raised because it requires less care and labor than other crops, and this supposition accords with the recognized habits of the Madawaskans. I have been told by an acute observer, that this protracted use of "Rough buckwheat" as an article of food, is not without its effect upon the people. The remark was made that the Madawaskans were afflicted with a troublesome cutaneous irritation, in consequence of eating this grain. In fact the story has already obtained some credence among the lumbermen of the river; but careful inquiry failed to confirm the notion A slight constitutional disturbance is the immediate result of a change from wheaten flour to buckwheat used exclusively; but not more than attends any important change of diet.

Perhaps the extensive manufacture of sugar from the sugar maple, entitles the tree to be placed in this class. At Black river we noticed a good many maple trees, and further down, many more; but it was not till we had passed Little Black river that this tree began to be very plenty. All down the St. John from this point last named, a great many of the inhabitants are engaged, in spring, in preparing the sugar, and large quantities of the nicest sugar are sold to speculators, who buy it for the St. John Market.

POLYGONUM TATARICUM.

In closing this part of the report, I must be permitted to again say that careful and thorough exploration was of course confined to the immediate vicinity of the rivers and lakes, and therefore the observations about the timber lands must be regarded as necessarily applying to only a narrow margin of land bordering the water.

I now approach a part of the report which is of peculiar interest to me. During the latter portion of the season, I was enabled to visit a portion of Eastern Aroostook. I was at once struck by the singular difference between its vegetation and that of Northern Aroostook which we had just left. Upon examining my specimens collected there by myself, and those received through the kindness of a botanist resident at Ashland, I found among them several plants which belong to a more southern parallel. These characteristic plants seem to occupy a belt running north and south along the border, and a portion of the belt extends south-westward to the Wassataquoik. Of course the limits are not as yet well defined—this work must be left for a subsequent survey,—but a list of the characteristic species will be given, in order that those in Aroostook, interested in Botany, will note the occurrence of them in their county.

Anemone Pennsylvanica, *L.*
Adlumia cirrhosa, *Raf.*
Claytonia Virginica, *L.* Near Ashland.
Acer dasycarpum, *Ehrhart.*
Lobelia Kalmii, *L.*
Pogonia verticillata, *Nutt.* Communicated by Rev. Mr. Keep.
Platanthera Hookeri, *Lindley.*
Aralia quinquefolia, *Gray.* By Mr. Currier.

The fact that these plants should be found in a section so far north, is interesting, and the more so, as the northern species seem to have given place to these, and they were not seen at all within the belt of more western vegetation. Very likely the same influences which combine to encourage in Eastern Maine the growth of the plants of Western Massachusetts, aid in the development of the fertility of Aroostook, giving to the farmers of that section a more southern climate. And it will be not only interesting in future exploration to determine the limits of such vegetation, but it will be of great importance to farmers, as the same limits will define the boundaries of land in Aroostook which may be cultivated to the best advantage. It is not only along the Aroostook and Presque Isle rivers that these plants have been collected, but they have been noticed in other places remote from the river interval. Upon what this limit of species depends it is not possible, even now to conjecture. This, with other important questions, will be reserved for future investigation.

I wish to state, in closing, that I have arranged the duplicate specimens collected this season in sets which can be distributed among those institutions of our State in which botany is taught, or be disposed of in exchange, or otherwise, as may seem best, and it is my sincere wish and hope that the specimens may be the means of increasing interest in botanical pursuits.

I have the honor to be, sir,

Your obedient servant,

G. L. GOODALE.

REPORT

ON THE INSECTS COLLECTED ON THE PENOBSCOT AND ALLEGUASH RIVERS, DURING AUGUST AND SEPTEMBER, 1861.

BY A. S. PACKARD, JR.

I here enumerate most of the species of insects collected during a rapid canoe journey through the northern part of the State, undertaken at the close of the season, when very many insects had already disappeared. The considerable number of new species noted shows how much remains to be done by our naturalists in this department.

I am indebted to Messrs. Ulke of Washington, Norton of Farmington, Conn., Uhler of Baltimore, Scudder of Boston, and Baron Osten Sacken of Washington, for naming insects of the several orders Coleoptera, Hymenoptera, Hemiptera and Neuroptera, Orthoptera, and Diptera.

Between Bangor and the Piscataquis River the following specimens occurred: *Acheta* n. sp., a small black Phryganid, *Æshna 4-guttata*, *Gomphus* n. sp., *Diplax costifera*, *Agrionidæ*, *Cicindela hirticollis* on the sandy shore, *Aphodius fimetarius*, *Eumolpus auratus*, *Calligrapha scalaris*, *Galeruca rufosanguinea*, *G. sagittariæ*, *Lebia moesta*, *Ellychnia autumnalis*, *Bolboceros filicornis*, *Hallomenus scapularis*, *Paria oterrima*, *Anchomenus extensicollis*, *Cymindis* n. sp., *Dineutes* sp., *Buprestis fasciata*, *Leptura canadensis*, with a *Moraellistena*, common on Golden Rod.

In the evening of the 8th August we found the army worm in considerable numbers in a barley field at Mattamiscontis. It did not occur on any farm above this point on our route. *Polystœchotes nebulosus* flew into our camp fire here. *Oedipoda carolina* and *latipennis*, *Colias philodice*, *Satyrus alope* and *nephele*, *Vanessa antiopa*, *Argynnis daphnis* and *Lycaena americana*, *Tipula costalis?* with Phryganidæ and several moths, were common here. Upon De Grasse's farm the Grain Aphis was very abundant, on the oats especially. At the Grindstone Falls three species of *Perla*, *Chrysopa* sp., *Phytocoris lineatus*, *Gomphocephalus nabiformis*, *Nabis* *ferus*, *Capsus multicolor*, *Capsus* non descr., *Capsus* n. sp., *Alydus eurinus*, *Tettigonia 4-vittata*, *T. mollipes*, *Deltocephalus* n. sp., *Helochara communis*, *Aphrophora 4-notata*, *Capsus multicolor*, *Typhlocyba* sp., and an *Idiocerus?* sp., were little hermipters common in the herbage. *Calopteryx maculata*, with the following beetles, also occurred: *Attelabus rhois*, *Cryptocephalus nortus*, *Phaedon viride*, *Anaspis flavipennis*, *Sitonus lepidus*, *Octhredomus dorsalis*, *Anthrenus flavipes*, *Crepidodera nana*, *Mordella lineata*, with several hymenopters: *Bombus virginicus*, *Ammophila placida*, *Eumenes fraterna*, *Cerophales* n. sp., *Allantus verticalis*, *Emphytus mellipes*, *Crabro orcuatus*, *Halictus pilosus*, *Cerceris?* n. sp., with *Chrysops vittata*, *Authrax fulviana*, or an allied species, *Eristalis flavipes*, *Helophilus* sp., *Tabanus* sp., *Tachina* sp., and *Simulium ornatum*, the "black fly" which is the terror of the forests of Maine and British America.

August 13th, while nooning at Whetstone Falls, I took on Apocynum cannabinum or Dogsbane, *Chrysochus auratus*; also *Chrysobothris femorata*. I tried unsuccessfully to capture *Limenitis arthemis*. At Hunt's Farm *Pieris oleracea* was frequent. Here also occurred a new species of *Chloëaltis*, and a fine large water beetle, *Dytiscus confluens*.

The 15th, warm and pleasant, was spent upon Mount Katahdin. Near the limits of trees, a *Larentia*, and a Crane fly, *Credicia albivitta*, and in the "slide" very near the summit above the limits of tree *Locusta latipennis*, were flying about the rocks. A diligent search in the low herbage, and under the stones upon the summit of the mountain, revealed the following beetles: *Clytus speciosus*, *Acidota subcarinata*, *Coccinella picta* northern var., *Brachyacantha* n. sp., *Corybites aerarius*, *C. triundulatus*, *Syneta tripla*, *Thanasimus dubius*, *Crepidodera violacea*, *Buprestis maculiventris*, with two staphylinids and another beetle. *Caloptenus femur-rubrum*, the common red-legged grasshopper, with its pupa, was frequent. Sixteen species of hymenopters, mostly ichneumons, including *Formica pennsylvanica*, and a small reddish ant, which was very abundant, represented this order. Two species of Phryganidæ, three homopters, and a fine *Arma*-like bug, with a large Aphis, and four species of Syrphi, including *Spilomyia excentrica?* and *Eristalis dimidiatus*; and *Simulium ornatum*, with five species of Muscidæ, and a *Thrips*, complete the list.

At the base of the mountains, among several moths not identified, was a pretty geometer, *Stegania pustulata*. In Beaver Brook, further on, occurred a larva of *Belostoma*.

At the foot of Grand Falls *Systena frontalis* was a common beetle on the wild peppermint. *Galleruca marginella* occurred in all its stages on myrica gale. The pupa of *Eurypalpus lecontei* occurred frequently in the river on stones. I took here a small butterfly very rare in New England, *Poleommatus cratægi*, with *Hesperia wamsutta*, and also *Bombus ternarius*, *B. virginicus*, and a large red *Tettigonia*. Under stones *Rhaphidophora maculata*, and on the surface of the river *Gerris paludum*. *Chrysopa vittata* and *niger* were very annoying biting flies. *Tachina vivida*, *Elephantomyia canadensis*, *Rhamphomyia* sp., *Dasypogon* sp., with various Syrphi, Tipulidans, *Chloroperla* sp., *Tetrix cristata*, *Chloëaltis* n. sp., *Ceresa bubalus*, *Homaemus exilis*, *Ptyelus bifasciatus*, with other homopters, *Adoxus vitis*, *Disonycha punctigera*, *Coccinella tricuspis*, *Photuris pennsylvanicus*, *Pterostichus luczotii*, an Elaterid, a red variety of *Formica pennsylvanica*, and other hymenopters, *Coelioxys octodentata*, *Odynenes pertinax*, *Pemphredon concolor*, *Osmia similima*, *Megachile* perhaps *brevis*, and several ichneumons, and a new species of dragon fly of the genus *Ophiogomphus*, were captured here. Upon the logging road to the dam on Grand Lake *Panorpa americana?* was more common than usual.

At Trout Brook Farm the following insects were noticed: *Anchomenus extensicollis*, *Geotropes splendidus*, *Phyllobrotica decolorata*, *Staphylinus villosus*; the common grasshoppers named before; *Halictus imitatus*, *Allantus rufopectus*, *Vespa vulgaris*, *Ophion bilineatus*; *Corizus borealis*, *Sinea multispnosa*, *Gyphona flavilineata*, a large aphis, besides the grain aphis, here also abundant on the oats, with *Tetanocera vicina*, *Ortalis* closely allied to the European *crassipennis*, and other flies of the genera *Chironomus*, *Dolichopus*, *Syrphus*, and *Asilus*.

On the ten mile carry from Grand Lake to Webster Lake, I took under sticks and logs: *Pterostichus coracinus*, *P. punctatissimus*, *Bradycelus quodricollis*, *Ochthedromus versicolor*, *Agabus angustus*, *Nomarctus bilobus*, *Cryptocephalus viridis*, with *Odynerus pertinax*, *Leptura vittata*, *Locusta flavovittata*, *Libellula rubicundula*, *Tingis hyalina*, and on Eupatorium in flower *Larentia russata*, a fine *Cidaria*, and other moths, flies and ichneumons.

August 31, at Chamberlain Farm, we had a little more time to collect. Here in great numbers occurred a species of Syrphus, and many bumble bees, *Bombus vagans*, *B. fervidens*, and *B. Americanorum*, and *Crabro interruptus*, with, besides the above mentioned grasshoppers, *Chloëatis curtipennis*, *Orchilimum gracile*, and a new species, and *Nemobius vittatus*, and the common cricket, *Acheta*. In the grass were many small homopters: *Proconia costatis*, *Schirus ligatus*, *Acanthosoma cruciata*, *Prostemma*, n. sp., *Acocephalus acutus*, *Plyetus linearis*, *Helochara flavicephala*, *Capsus linearis*, C. n. sp., and a species of Flata. Under stones, at the edge of Indian Pond, several beetles were taken: *Cimindis reflexus*, *Pterostichus luczotii*, *Trechus micaus*, and several staphylinids not named. On the alders were larvæ of Tenthredo, and on willows caterpillars of *Cerura borealis*. Here for the first time I took a large handsome green mayfly, *Palingenia bilineata*, either floating on the surface, or flying feebly on the grass by the shore. It occurred afterwards in greater abundance, with four other species of Ephemerids, on the Fish River lakes. Several Noctuids, among them *Mammestra arctia*, flew about lights at night. The dead cedars were much invested with an undescribed species of cylindrical bark borer, *Hylesinus*, which makes a central furrow, with smaller galleries branching out at right angles. This beetle was not noticed in upright healthy trees. On the grain upon the farm the aphis was abundant; on the turnip were small leaf-hoppers, *Psyllyodes punctulata*, which had eaten many holes in the leaves, besides other larvæ of beetles, and the caterpillar of *Pieris oleracea*.

Under stones at Churchill Lake three rare beetles were found: *Harpalus pleuriticus*, *Anisodactylus nigrilus* and *Agonum metallescens*.

At Monroe's farm on the Alleguash, the grain aphis was abundant in some oat and wheat fields, while others were free from them, but the grain thus attacked received, I was told, no injury, while farmers in Woodstock, N. B., were obliged to cut their grain green to save it from this aphis. In Mr. Monroe's garden I noticed *Plecia longipes* flying among the corn and other vegetables. Near here a handsome wasp-like fly, *Spilomyia*, was taken on an aster.

Afterwards, on the Fish River lakes, I took *Aphodius conspectus*, *Monohammus scutellatus*, *Tetrix harrisii*, a new species of *Gomphus*, *Pompilus funereus*, *Odynerus pertinax*, *Urocerus albicornis*, *Vanessa J-album* and *V. comma*, *Mammestra arctica*, *Ennomos magnaria*, and a fine *Cidaria*, and the common *Gerris paludum*.

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GEOLOGY OF THE WILD LANDS.

BY C. H. HITCHCOCK.

In the systematic account of the Geology of Maine in Part I, frequent allusions have been made to the character of the rocks in the more northern portion of the State, yet not as fully as was possible. As this section of the State is very little known, particularly the unsettled portions, we present the details of its geological structure, partly with a view to make the country better known, and incidentally to set forth its claims for settlement. The only system pursued will be a topographical one; *i. e.*, a description of the geology of the different routes pursued by the different explorers. We shall first, however, present a general geological map of Northern Maine, and briefly describe it. Then we shall describe the geological features, so far as is possible without a repetition of what has gone before, of the following districts or sections; 1, a section from Charlotte to Presque Isle; 2, a section from Penobscot Bay to Ashland, 3, the region travelled by the exploring party last summer between Mattawamkeag and the St. John river; 4, the region between the mouth of Seboois river and Masardis; 5, the region of the St. John river; 6, the region of the Fish river lakes and the country from thence on the Aroostook river to Presque Isle; and finally the country south-west of Mount Katahdin.

The following are the different authorities upon which we base our statements, in the order in which they are given above: our own observations between Charlotte and Presque Isle, as well as between Ashland and Penobscot Bay, with the exception of a few miles of Mr. Houghton's explorations below Bangor; our own observations between Mattawamkeag and the St. John river; Dr. Jackson's observations between the mouth of the Seboois river and Masardis; our own observations upon the St. John river; Mr. Packard's report upon the Fish River lakes; and Mr. Houghton's report on the Moosehead Lake and West Penobscot river region. Any facts derived from sources not indicated above will be promptly ascribed to them in the proper place.

Geological Map of Northern Maine.

This map has been hastily prepared from the observations of the different persons just mentioned. The rocks represented upon it are the following:

Granite and Syenite,
Talcose schist,
Mica schist and Quartz Rock,
Lower Helderberg group, (Upper Silurian,)
Oriskany sandstone, (Lower Devonian,)
Devonian rocks,
Calcareous slates,
Slates, probably Devonian in part, and Silurian in part,
Trappean and altered rocks.

The granite and syenite occur in several isolated patches, viz: near the Canada line on the Canada Road; on the south-east side of Moosehead lake; on the east shore of Brassua Lake; the great development in the Katahdin region; a small patch south-west of Masardis; others in Island Falls and Linneus; in Enfield; and extending from the region of Topsfield westerly and into New Brunswick, where it is largely developed on the east side of Schoodic Lake.

The talcose schist is found in two patches; the first a very extensive region on the upper St. John waters, whose limits are unknown; and the other extending from Patten northeasterly about 25 miles.

The mica schist associated with some conglomerates and a considerable quartz rock probably covers a large area, rather of a wedge shape, extending from northern Washington county, where it is narrowest, into New Brunswick, where it has not been traced by us beyond the St. John river. Two other strips of it appear in Washington county.

The Lower Helderberg group has been found only in patches, which are so represented, but are doubtless joined together, though in a way not understood. Its most Southern development on the map is at the base of Squaw Mountain on the south-west side of Moosehead Lake. We know not whether the rock is sandstone, limestone, or mica schist. For its existence, we depend upon a list of fossils procured in that region by Mr. Hodge, one of Dr. Jackson's assistants. He also found the same fossils in limestone at Ripogenus Falls on the west branch of the Penobscot river. The Katahdin granite region may have severed the connection between this group of strata on the West and East Branches of the Penobscot, but we find traces of them on the East Branch as low down as Township No. 3. The first certainly known locality is on the Seboois river in rather small beds on Peaked Mountain in No. 6. Another on the same waters is at the Second Seboois Lake in No. 7, R. 7. What we suppose to be the same belt of rocks, although it is not represented upon the map, is the bed of limestone and marble discovered by Mr. Basten in No. 7, R. 6. The same Helderberg limestone crops out upon Horse-shoe Pond in No. 5, R. 8. We lose sight of it now until we arrive at Ashland, for the reason that the country between has never been explored. In Ashland it may be traced for nearly three miles, and extends without doubt much further in both directions. We have connected together upon the map the localities at Square Lake, and on Fish river south of Long Lake.

The Oriskany sandstone forms a wider belt, and its course can be followed more easily, because the rock contains characteristic fossils, and is so siliceous as to resist decomposition. Its most south-west locality is at Parlin Pond, then it is seen on Moosehead Lake, Chesuncook Lake, Telos and Webster lakes, and the Aroostook river. This region is easily mapped, except so far as doubt exists as to the width of the belt.

The rocks called Devonian are mostly sandstones containing fossils, which at the time of writing the report have not been determined. This group of rocks has been seen no further west than the East Branch of the Penobscot in Nos. 5 and 6. On the Seboois river they extend from Peaked Mountain in No. 4, to No. 7. Rocks of precisely the same character were not seen where this band is represented as crossing the Aroostook road, but on the line of strike red sandstones, etc., appear in Mapleton and in the mountains south-west of Presque Isle. Also in an isolated patch on Mars Hill. A second set of sandstones appear in Ashland and eastward on the road to Castle Hill, as well as in the valley of the Aroostook river. The third belt of Devonian sandstones, etc., runs from Long Lake on Fish river to Long Lake or Madawaska lake in No. 18, R. 4.

The distribution of the calcareous slates, which are probably Upper Silurian or Devonian, is more simple, in Maine. They occupy most of the eastern part of Aroostook county in the first two ranges of townships, and a belt runs off from the principal deposit to the north-west corner of Patten.

Probably these calcareous slates are of the same age with the next heading on the map, of slates of uncertain Devonian or Silurian age. These are made to cover the regions between the Oriskany sandstone and the Devonian rocks, also between the two principal Devonian belts, and the region west of the Oriskany sandstone on the Canada road, and north-east of Chamberlin Lake. Lithologically, these slates resemble portions of the Oriskany sandstone.

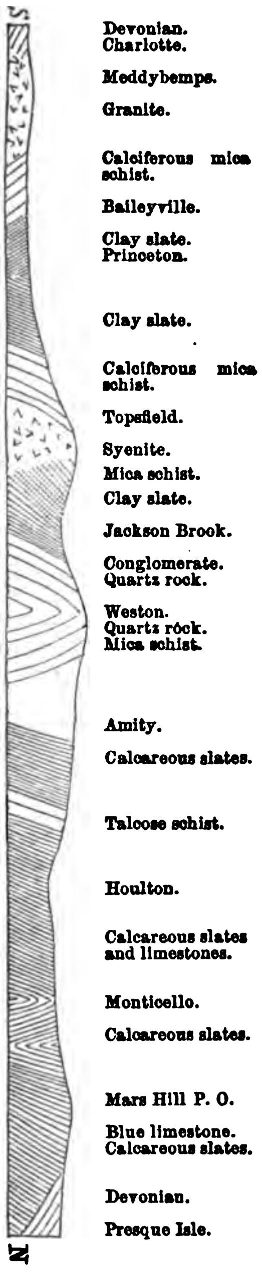
The clay slates cover an immense district. Part of them are Lower Silurian, as, for example, the immense deposits on the south part of the map. The immense district of clay slates on the St. John and Allcguash rivers may be Silurian or Devonian. Although these three classes of slates are indicated thus indistinctly, we have thought it better to represent them even thus poorly than not at all. Geologists will thus have some data upon which to speculate.

The last distinction upon the map is an exceedingly general one, including trap and porphyry rocks, trappean and associated conglomerates, and siliceous slates. The dikes, etc., are developed on Chesuncook Lake, East Branch of the Penobscot, and some portions of Chamberlain, Eagle and Churchill lakes. The conglomerates occupy the rest of the borders of these lakes. The siliceous slates are found on Moosehead Lake, the Travellers on the East Branch, sparingly upon the Seboois river and Eagle or Heron Lake, and very largely about Portage Lake, and the Long Lake of Fish river.

Section from Charlotte to Presque Isle.

Commencing in the south-west of Charlotte, we find dark-colored sandstones dipping 35 degrees northerly, and containing a genus of fossil shells—the *Orthis*—in great abundance. Within a stones' throw of this locality, (it is on a little ridge of land,) we find a ledge of granite. We find the granite occupying higher land than the sandstones, which we have referred to the Devonian series from their stratigraphical connection with the plant-bearing beds in Perry. Whether the sandstones dip under the granite, have been changed into the granite, or simply overlie it, we are not now prepared to state. The granite may be found to extend into the south part of Baileyville, without intermixture with other rocks, unless it be syenite and protogine.

The first stratified rock north of the granite is mica schist, at E. Reding's house in the south part of Baileyville. The strata dip 55 degrees north. Just north of Wapscanegan Brook they dip 68 degrees north, and near where the road crosses the west line of the town, they dip 70 degrees north-west. This embraces nearly the entire width of the formation. It must be noticed that this band is the *calciferous mica schist*, and may be very distinct in geological age from the mica schist further north. A calciferous mica schist in Vermont and Massachusetts



Section from the south part of Charlotte to Presque Isle.

FIG. 12.

appears to belong to the Upper Silurian group, but lithological appearances are of very little value in the determination of rocks, and therefore we must not assume that they were produced at the same time. One resemblance between the Vermont and Maine rocks may be of interest to the farmers. The calciferous rock in Vermont is covered with numerous beds of marl, derived from the decomposition of the rock primarily. We anticipate upon this belt in Baileyville, as well as upon two or three other calcareous rocks to be mentioned presently, the discovery of similar beds. We advise the farmers of Northern Washington and Aroostook counties to look beneath all their peat bogs, and around the borders of their ponds for this white powder, containing small shells. The marl may not always be white, but it can always be known by the application of an acid or strong vinegar. If the suspected substance fumes up or effervesces when the vinegar is applied, it is certainly marl, and will enrich their lands.

The rock overlying the calciferous mica schist, and the next one seen on our section, is clay slate. Very little of the rock was seen upon our route in Princeton before reaching the enterprising village called Lewey's Island, as the surface is covered with alluvial deposits connected with the St. Croix river. In company with a citizen of the town, whose name has escaped us but who was very kind to us, we walked down the railroad a mile or so where the ledges of slate had been cut through by blasting. The clay slate here contained several small beds of limestone, like those found in the mica schist. The strata dip about 60 degrees northerly. We heard of more limestone in the vicinity, but had no time to visit the locality. We found boulders of a very pretty breccia on the railroad track composed of trap, jasper, epidote and calcite. It has a trappean aspect, and may have come from the trap dikes in the vicinity of Lewey's Lake noticed by Dr. Jackson.

The rocks in Indian Township are like those in Princeton. They are mostly covered with soil, which is of very good quality. Our experiences in this township were such as to make us recommend that when it receives a name from the Legislature that it be incorporated as Musquito Plantation. The reasons for this suggestion will be very readily perceived. The clay slates in the Indian township and Waite dip southerly. Thus, as the section in Fig. 12 shows, the slates are repeated, and form what geologists call a synclinal axis. It will be noticed that we pass over the same rocks twice in consequence of this repetition of the strata. A fact is also shown here and elsewhere on the section, that when strata are repeated, either on a synclinal or anticlinal axis, the amount of inclination generally varies on the different sides of the axis. In this example, the southern inclination on the north side of the axis is greater than the northern inclination on the south side of the axis.

We should have said before this that in Fig. 12 we have given a section of the rocks on our route, which will show their position much better than our remarks could. The section shows all the hills and valleys of the route as well as the position of the strata.

In Waite, the calciferous mica schists that we saw in Baileyville have again come to the surface after a mighty sweep deep in the earth beneath the clay slates, as the section will indicate. The same rock continues to Topsfield, and we cross the strata a little transversely. South of Dudley's Hotel in Waite, these schists dip 70 degrees south-easterly, with the strike north 38 degrees east. Beautiful drift striæ appear on the ledges running north 8 degrees east, which were made by icebergs early in the alluvial period. In the north part of Tallmadge, the rocks of this belt are very fine sandstones of a light color when weathered, apparently with perpendicular strata running north 6 degrees east. But if the observer looks carefully he will find that these supposed strata are only the cleavage planes, or divisions of the rock which have been produced by chemical or galvanic forces since the deposition of the strata. Bands of different colors appear in the ledges running nearly at right angles to the course of the cleavage planes, which are the true marks of stratification. They dip 35 degrees south. The same rocks continue to Topsfield, underlying a great many large boulders of granite and trap. The soil is good, though sometimes rather stony.

A short distance above the cemetery in Topsfield the mica schist is replaced by syenite. It forms a narrow ridge, as the mica schist reappears before we reach the northern boundary of Topsfield. And there are several high mountains in Topsfield and vicinity whose outline shows them to be granitic; *e. g.*, Musquash Mountain, and the peaks south of Baskahegan Lake. The syenite forms a high ridge where the road crosses over it. The ridge runs easterly till it crosses the St. Croix river and connects itself with the granite of New Brunswick. The syenite of Topsfield is very pretty but would decompose easily—at least some portions of it would.

The mica schist of the north part of Topsfield is of small amount and dips 23 degrees south, just as if it passed beneath the syenite, making the latter a bed in mica schist. We suspect this to be the true position of things beneath the surface. This schist crops out on the west side of Little Tomah Lake.

The clay slate succeeding appears first quite near to the north line of Topsfield, dipping about 50 degrees south-east. Numerous bands of bright red slate are interstratified with the grey. The position near Jackson Brook Hotel in No. 9, is the same.

No rocks are seen in place between this Hotel and the north part of the second township No. 9, where mica schist and conglomerate rocks with curiously distorted pebbles are found, dipping 65 degrees east, or with the strike north 8 degrees west. As this position does not agree with that of other rocks in the vicinity, we suppose it to be a local exception. We have dwelt so largely upon this conglomerate and the inferences to be derived from it in Part I, that we will simply refer to it here. We consider this mica schist as essentially the same rock as that in Topsfield. Upon referring to Fig. 12, there will be seen the possibility of an inverted synclinal. Suppose this belt of mica schist to be continued beneath the section in a curve until it meets the Topsfield schist; this would make the clay slate an inverted synclinal also, overlying the schist. Other methods also might be suggested as to the nature of the connection of these bands, whose value will be determined in future by personal observations of the territory.

The drift accumulations near the borders of the two number nines are quite interesting. On the east side of the carriage road they have the form of moraine terraces, and crossing it there seems to be a horseback. The former deposits are more or less arranged in lines parallel to the horseback.

There is a considerable amount of quartz rock in this belt of mica schist, which extends into the south part of Weston, where a ledge of blue quartz rock dips 70 degrees south. In the north part of Weston, a ledge of mica schist crops out, dipping 70 degrees north. Thus there is in this town an anticlinal axis, both sides of which are quite steep. There are three peculiar rounded hills in Weston, which resemble peaks of granite. The rocks in Orient are entirely concealed by drift. The road passes for several miles over the top of a horseback.

Just beyond the Post Office in Amity we come to the calcareous slates of our map, with the strike north 55 degrees east. From this point the section does not cross the strata so nearly at right angles as before. In No. 11, the township between Amity and Hodgdon, these slates run north 15 degrees east, and dip 70 degrees easterly. These slates occur in the south part of Hodgdon in abundance. Among them are manganesian strata. A few rather poorly developed moraine terraces show themselves here. Several beds of talcose schist show themselves in the north part of Hodgdon dipping to the south-east. In the south part of Houlton, the calcareous slates dip 75 degrees south-easterly.

The horseback is well developed in Houlton within sight of the village. It is probably the same with the one mentioned in Orient, where it has been cut through by the Meduxnekeag river. At Cary's Mills it is 90 feet high. The soil derived from the decomposition of the slaty calcareous rocks in Houlton is excellent. Occasionally a small portion of it is sandy, as a small district upon Hon. Shepard Cary's farm, adjacent to the horseback. The soil in a part of Linneus, according to Mr. Cary, which at first was very promising, has not answered expectations, although the subjacent rock is similar to that in Houlton. Here is a practical difficulty to be removed; what shall be done to the soil to improve it? Very likely a careful analysis of the virgin soil, the exhausted soil, and the subsoil, will show what principle may be wanting. We hope that the survey will be enabled to render assistance in this case.

In Houlton and vicinity the slaty rocks take much more lime into their composition, so that often they ought to be called limestones. On the road to Monticello for about three miles, the rocks are uniformly slaty, running a few degrees east of north, the road barely crossing them, and the strata stand nearly vertical. Then the rock changes to the limestone variety, which often shows small plications in the strata. At one place they had been bent to so small an angle as 55 degrees. The rocks in Littleton are the slaty variety mostly. We found also large boulders of a conglomerate which is probably in place near by. In the south part of Monticello the calcareous slates dip 85 degrees south-east. At the Archibald House, the strata dip 75 degrees north-west, thus making an anticlinal axis with the slates in the south part of the town. In the edge of Bridgewater it changes again, and dips 70 degrees east, with the strike north 16 degrees east. At Wilson's Mills the limestones predominate, dipping 60 degrees east, with the strike north 20 degrees east. Mars Hill (the mountain,) is composed of Devonian sandstones, like those on Sugar Loaf Mountain, according to Mr. Hodge.

The rocks between Houlton and Presque Isle are all of the same general character. The country is undulating, but the hills are generally low. It is a magnificent agricultural region, and its rapid settlement shows that its merits are appreciated by the farmers. For emigrants, this region affords two very important advantages over the Western States, with the same kind of soil; 1, the Aroostook country is nearer the markets, so that produce can be sold at a better price, and communication with the business world made more easy; 2, the settlers in Aroostook county are never troubled with the "chills and fever," so universal in the new settlements of the west. The climate of Northern Maine is the same as that of a portion of the West; and the advantages of position and healthiness more than counterbalances the climate when compared with the other portions of the West.

Immediately west of Presque Isle the red Devonian sandstones appear with a dip of 45 degrees west. The rock is of the same age with that on Mars Hill, and the East Branch of the Penobscot.

Section from Penobscot Bay to Ashland.

This section follows the Penobscot river to Mattawamkeag, and then the course of the Aroostook Road. Commencing at St. George, we find the whole peninsula composed of granite. In South Thomaston are the slates, limestone or dolomite, and quartz rock belonging to the Taconic series. Owl's Head is entirely composed of trap rock. The precise relations of the several bands of limestone, quartz rock and mica schist are not yet understood. The mica schist is seen north of Rockland on the Camden road for a considerable distance. Near the town line this schist dips 79 degrees north-west. A mile into Camden the dip is reversed, being 40 degrees south-east. In Rockport we find quartz rock dipping 40 degrees north, underlying a slaty rock dipping 20 degrees north, and that beneath limestone, of the same age as that in Thomaston. The slaty rock is of considerable thickness, as the limestone is found about midway between Rockport and Camden village, where it dips 26 degrees north. The upper part of the quartz rock belt is siliceous slate. A new quarry for lime has recently been opened in Camden by C. C. Smart, which promises well, it being the direct continuation of a beautiful bed of limestone worked formerly, but supposed to have been exhausted. Galena is found in Camden, which was examined by Mr. Houghton, who reports that it is only a small vein.

Arriving at Camden village, we see in the streets ledges of mica schist standing upon their edges. Megunticook mountain is composed of quartz rock and a micaceous conglomerate, all of the same type of rocks. Very shortly, however, we find azoic rocks of different age, probably an older system of rocks. This is in the north part of Camden where an imperfect gneiss rock dips 27 degrees south-east. At the Beach in Lincolnville, the rock is siliceous slate. A mile beyond, in Northport, a mica schist appears, dipping 70 degrees south-east.

In the south part of Northport interstratified gneiss and talcose schist dip 75 degrees north. At the Witherby House a large bed of gneiss has been changed into a beautiful granite. In the north part of the town a gneiss rock dips 80 degrees south-east. All these rocks below Belfast and above Camden, are of the same type as the mica schist and gneiss along so much of the coast west of Thomaston. Northport Mountain, 486 feet above the Bay, has granite for the center, gneiss dipping away from the top of the mountain in opposite directions, and the gneiss is overlaid on both sides by irregular slates, of which those exposed in the village of Belfast are samples. They probably contain calcareous masses, judging from the character of the well water in the town. Of the nature of the rocks between Belfast and Fort Knox, we have no knowledge, but suppose them to be slates similar to those in Belfast.

The rocks at Fort Knox in Prospect are mica schist, dipping 3 degrees north. In the south part of Frankfort are immense mountains of granite, as Musquito Mountain, etc. North of these mountains on the west side of the river, are gneiss rocks, and then clay slates to Bangor. They dip 70 degrees west-south-west in Hampden.

Crossing over the Penobscot river to Bucksport village, we find an anticlinal axis of clay slate overlaid on both sides by hornblende and mica schist, the dip at the village being 70 degrees north-west, and the east side of the axis extending into Orland. Two and a half miles north of Bucksport village the mica schist dips 16 degrees south-east, thus forming a synclinal with the strata observed above.

Near the Bucksport line in Orrington the mica schist changes again, dipping 63 degrees northerly with the strike north 70 degrees east. At South Orrington village the rock is granite. In the north part of the village quartz rock and gneiss appear, dipping 65 degrees northerly. Beyond this appears the clay slate, dipping 75 degrees west, which we shall find to extend uninterruptedly from this point to Patten, a distance of more than 90 miles in a strait line. In the north part of the town the slate dips 60 degrees north, and then from 50 to 70 degrees north-westerly. In Brewer the dip is 27 degrees north-west. For the observations between Bucksport and Bangor, Mr. Houghton is responsible.

Numerous deposits of the marine clays and sands containing fossils occur up the river as far as Bangor. There are two layers; the lowest containing fossil shells, and the upper one, more sandy, being filled with tubular and cylindrical concretions. The remains of a whale were found in them by Dr. A. C. Hamlin of the United States Army. It is said that these deposits are overlaid by the unmodified drift.

In the north part of the city, the clay slate, interstratified with narrow beds of talcose schist, has the strike north 75 degrees east, dipping 75 degrees north-westerly. The same rocks appear all the way to Oldtown and Milford, where it appears to be nearly perpendicular. Near the mouth of Sunkhaze stream the dip is to the south-east. Near Morrill's hotel in Greenbush, there is an immense bed of clay which would make good bricks. Some strata of consolidated sand occur in the upper part of the clay, which is probably fluviatile. Near the clay is a ledge of clay slate, whose strata dip 65 degrees south-east. The valley of the Penobscot grows wider above Milford, and the meadow lands on both sides are frequently very extensive, reaching so far back from the river that we were unable to trace the outline of the terraces above the first. Much of this meadow land is sandy, and needs reclamation. The surface geology of the Penobscot will be very interesting when its peculiarities shall have been made known.

Near Passadumkeag village the strata of clay slate dip 70 degrees south-easterly. Three miles above Passadumkeag they dip 65 degrees north-westerly, making an anticlinal axis. At the Locks in Enfield the strata have essentially the same position. The river here runs over a great many ledges and boulders, making a canal necessary for the passage of the small steamboat which passes up and down the river in early summer. In Lincoln the position of the strata appears to be the same as before. At the Five Islands in Winn the rocks are talcose, and run north 55 degrees east, with the dip of 80 degrees north-west. Below Mattawamkeag village the rocks are more distinctly clay slate than for 15 miles still lower down. At the "Point" the rock is talcose, dipping 64 degrees south-east. Boulders of white marble are found in the river between the Five Islands and Mattawamkeag.

Leaving the river now for the Aroostook road, we find the surface undulating, and the rocks in great measure concealed by coarse drift. The valley is very narrow at Mattawamkeag, and there are scarcely any appearances of terraces except the meadows on the two streams, the Penobscot and Mattawamkeag rivers.

Two ledges of clay slate appear between Mattawamkeag and Molunkus. About three miles north of Molunkus Hotel the clay slate dips 60 degrees south-east. The country in Township No. 1 is unsettled, except a very few houses in the center of the township. Before arriving at these we noticed several bands of fine roofing slate enclosed in a coarse kind of clay slate almost talcose. These beds run north 15 degrees east, and may be the result of cleavage. The strike presently is north 25 degrees east, and the dip 51 degrees west. Between No. 1 and Benedicta the texture of the argillaceous rocks is mostly like that of a schist.

Half a mile south of the Catholic church the strike of the clay slate is north 55 degrees east, and the dip 70 degrees north-westerly. Near Trafton's Hotel in Golden Ridge, the dip is 85 degrees north-west. A horseback north-east of the hotel is four miles long, and another north-west is about a mile in length. The last ledges of clay slate seen are south of the village of Patten.

We have thus indicated the presence of three anticlinal and two synclinal axes over this clay slate area of 90 miles. Supposing the rock to be the same over this district, they have been repeated by foldings ten times. We expect a rigorous examination of the section will increase the number of folds. Our observations were mostly isolated.

Talcose schists extend on the course of the Aroostook road from Patten to the north part of No. 6, R. 5. At first the dip is north-westerly. About a mile above the south line of No. 6, the strata dip 75 degrees south-east. There is a bed of azoic limestone in the south part of this township. The varieties of the formation thus far are an argillo-talcose schist, characteristic talcose schist talco-micaceous schist, and talcose quartz rock. The total width of the belt cannot be more than six miles, although the road crosses it transversely. The last ledge of schist seen was almost as soft as steatite, and some portions of the rock might be used for soapstones. It is about a mile and a half from the north line of No. 6, the strata being vertical with the strike north 20 degrees east.

The rocks next seen are an alternation of clay slates, grits and sandstones, generally showing a high inclination to the north-west. Gravel occurs occasionally upon the road, and the soil is generally not as good as upon the other section. In the lower part of No. 7 we find boulders of dark-colored fossiliferous limestone. They belong probably to ledges of the same rock found in the north part of the town. These limestone rocks we suppose are of Devonian age. The limestone is so abundant in this township that it is burnt for quicklime. It is in No. 7 that the marble is found. In the south part of No. 9, R. 5, are ledges of blue quartz rock dipping to the south-east. The same rock still further north dips 50 degrees north-west.

In Masardis we find near the village a dark-colored grit dipping 45 degrees westerly. Between Masardis and Ashland the rocks on the road are concealed by drift.* Above No. 9 the soil has greatly improved in quality, and the meadows upon the Aroostook river are extremely fertile. Ledges of limestone crop out on the banks of the Aroostook between Masardis and Ashland. They are probably the continuation of the Lower Helderberg limestone of Ashland, (Blake's Farm,) which dips 75 degrees west, with the strike north 25 degrees east. This limestone, as before remarked, is an anticlinal belt separating the Devonian rocks above it from each other. On the bank of the Aroostook river opposite the mouth of the Big Machias River, there are strata of very fine dark-colored argillaceous sandstones dipping 65 degrees west, which overlie the limestone. We know not whether they are of Devonian age. Their only fossils are numerous obscure fucoids and remains of higher plants profusely scattered through the layers. Its total thickness cannot be more than 50 feet.

The Devonian rocks in Ashland east of the limestone belt are mostly conglomerates, more or less indurated, and composed of pebbles of red jasper, green and variously colored siliceous slates. Their source was probably the altered slates to the north in Nashville. The conglomerate a mile and a half east of Ashland dips 30 degrees south-west. A fine gray grit east of this, resembling some grits or sandstones of the coal formation, (much like grindstones,) dips 75 degrees west. This rock contained relics of plants. Two miles east of Ashland the Devonian rocks consist of friable slates, much like fire clay hardened, and sandstones. The slates are usually divided by cleavage planes. Near the east line of Ashland there are very coarse conglomerates and trappean rocks.

From Mattawamkeag to the St. John River.

The description of the geology of this section of country will include the geology of the East Branch of the Penobscot; of Mt. Katahdin; of Webster Creek and Lake; of the Alleguash lakes, and the Alleguash river, or the district travelled over in August and September by our large exploring party, whose history has been already given.

The rock at Mattawamkeag, as already remarked, is talcose schist, a member of the clay slate formation, dipping 64 degrees south-east. In ascending the Penobscot we find alternating layers of clay slates, occasional talcose schists, and grits, all the way to the Pond Pitch of the Grand Falls. At the mouth of Salmon Stream in the south-east corner of Nicatou, these grits and slates dip 70 degrees north-west, making an anticlinal axis with the rocks at Mattawamkeag. A mile above Salmon Stream the dip is 50 degrees north-west, and still further 60 degrees north-west.

Boulders of marble along with slate, granite, etc., are everywhere seen in the bed of the river. A mile and a half below the village of Nicatou there are two small and very pretty alluvial terraces on each side of the river. The island at the junction of the two branches of the Penobscot is the remnant of a high gravel delta terrace, deposited by the west branch. Another part of the same terrace is at the fork itself. Back from the river coarse drift with boulders everywhere shows itself.

Two miles up the East Branch at Ledge Falls, the rocks are slate, grit and conglomerate, very much distorted, but with an average dip of 60 degrees north-west. It is an interesting locality for examples of small plications of the strata, and also for examples of cleavage planes and laminæ crossing the strata. The two planes cross the strata at various angles from 30 to 40 degrees. The strata stand upon their edges at the north end of the Falls. Some of the strata are bent, so that portions of them resemble a row of fossil upright trunks of trees. The layers are both thick and thin bedded. A conglomerate composed of large pebbles of calcareous slates is imbedded in the grit. A short distance north these pebbles are flat and elongated. A quarter of a mile north of the Falls the strata are perpendicular, running north 70 degrees west.

Two terraces are found on both sides of the river through most of the town, and at Mr. Hiram Fish's house they are remarkably beautiful. Their material is gravel. Higher up there are three and four terraces rising above one another in regular succession. In the south part of No. 1, there is a patch of clay a rod long and rising 10 feet above the water, which is set into coarse and fine gravel just as if it had been elevated from beneath. It was probably deposited in a deep hole in the gravel bed.

The solid rocks grow more slaty in ascending the river. At the locality of the clay in No. 1, the clay slate dips 88 degrees north-west. A few rods above is a gray grit having the same position. At the Rocky Rips, above the mouth of Meadow Brook, the grits dip 75 degrees north-west. Half a mile above is a band of clay slate, with the strike north 28 degrees east, and a south-easterly dip of 80 degrees, or making a sharp synclinal axis with the strata at Rocky Rips. At Grindstone Falls the rocks are alternating strata, as before, of clay slates, fine grits and quartz rock, dipping from 85 degrees east to 90 degrees south-easterly. Numerous boulders of granite fill the bed of the river at the falls.

On the east side of the river at the falls are crushed ledges of slates, analogous to interesting examples we have described in Vermont. The ledge on the east side of the river is high—say 30 feet—and nearly perpendicular, but at its bottom at the water's edge are fragments of slate which have been broken off, scattered along at intervals for 20 rods. This pile of fragments is several feet thick, but is greatly reduced in size from what it has been, because the spring freshets have washed away many pieces from year to year. The force breaking off the strata appears to have come from the south-east. If one could imagine that a great rock 20 rods long happened to fall from the skies upon this particular spot, the results would be similar to what may now be seen.

The theory has been proposed that these ledges were crushed by the toppling over of icebergs when the country was under the ocean, or that a huge wave elevated an iceberg, so that when the wave receded the iceberg fell upon and crushed the ledges. We think the present case can be ascribed to frost and gravity. The water at the base wears away the bottom of the cliff and weakens the rocks there. The water which enters the fissures of the rock weakens the ledges still more by freezing. And as a heavy mass of snow and ice has accumulated in the winter upon the top of the cliff, it may be that its weight, combined with the weakening of the strata beneath, will cause the upper part of the ledge to fall down and present this crushed appearance. A similar example we saw in Houlton east of Cary's Mills, but the industry of the workmen have removed all the debris before this time. Where these examples of crushed ledges occur upon the south-east slopes of hills, it is conceivable that the strata were broken off by the drift.

This is a fine region for terraces, as compared with the rest of the State. One upon the west side of Godfrey's Falls is 72 feet above the river. From its top there is a fine view of Mt. Katahdin.

At the upper part of the falls the strata dip 60 degrees north-westerly. At Crowfoot Rips in No. 2, R. 7, the slaty rocks dip 80 degrees south-east. The rapids here are produced by the fall of the water over numerous blocks of granite. Beautiful blue clay is found in this township. About Brown's island the sand is cemented into alluvial sandstone by the peroxides of iron and manganese. At the Bear Rips the slates dip 75 degrees south east. A large number of boulders of the Lower Helderberg limestone were found at Whetstone Falls, containing in great abundance encrinal remains and the coral *Favosites Gothlandica*. These boulders in the town, ship above are very large, one of them being 14 feet in diameter and it would seem as if their source could not be far distant. The clay slates and grits at these falls dip 65 degrees southerly. The prevailing dip thus far is north-westerly, but we have passed over two anticlinal and two synclinal axes, at least, since leaving Mattawamkeag.

At Whetstone Falls we met Rev. M. R. Keep, who was to be our guide over Mount Katahdin. As we left the river for the mountain from Mr. Hunt's in No. 3, we will here digress from our narrative, and describe the trip to the top of the mountain.

Mount Katahdin.

The party ascending Mount Katahdin consisted of Mr. Keep as guide, Mr. Goodale as Botanist, Mr. Packard as Entomologist, Mr. Maxwell as an explorer on his own account, Mr. Davis as assistant, and myself as Geologist. Although we arrived at Mr. Hunt's in the afternoon, (Aug. 13th,) we determined to lose no time but proceed at once on our way. Accordingly, having selected our outfits, being well provided with salt pork and hard bread, and having made the several scientific preparations necessary for the different departments, we were started on our journey in the batteau, being polled up the Wissatiquoik river about a mile by our boatmen, Johnston and Thomas. Then we took up the line of march [illegible] Indian file through the immense undergrowth, produced by the wonderful fertility of the soil, to a beautiful little brook about four miles from Hunt's, where we camped for the night. On the Wissatiquoik, near its mouth, we found ledges of a bluish quartz rock very evenly stratified, and dipping 60 degrees north-west. Above them on the bank, the boulders and large masses of a limestone, similar to those seen at Whetstone Falls, are so numerous, that we believe the rock to be in place close by, certainly less than half a mile, if indeed we did not find it in place. The alluvium is so thick, (and the country is all a forest,) that it is very difficult to trace out the connections of the strata. Their supposed locality is about two and a half miles above Hunt's farm. Boulders of red friable amygdaloidal trap are very common for three miles, and must have originated from ledges a few miles to the north.

By noon of the 14th, we reached Katahdin Pond in No. 3, R. 8. No rocks were seen in place, and the boulders are all of granite, the last five miles of the way. The country is all a dense forest with much of the original growth still remaining. Our course a part of the morning was along the banks of the Wissatiquoik river, where we were struck by the rankness of the vegetation, indicating great fertility of the soil. But about Katahdin Pond the soil is poorer, and continues to be of this description to the mountain. We had not yet begun to rise much, as the Pond was found by the Aneroid Barometer to be 790 feet above Hunt's farm. We cooked our dinners here and had a magnificent view of the mountain. The sky began to thicken, and a few drops of rain fell before we left the Pond, and as the wind was from the north-east, we were discouraged, and thought some of returning. But our better genius urged us on, the skies brightened, and when we had scaled the summits no clearer day could have been desired.

The pond is seven miles from the mountain proper, and we were unable on the 14th to ascend the mountain very high, our camp for the night being 1,012 feet above the pond, and 1,862 feet above the east branch. We found no ledges all the afternoon, but the rocks are without doubt granite the whole distance. We ascended the valley of Avalanche brook on the south side of the mountain, and found an immense number of boulders and other remains of a great slide that devastated the valley a number of years ago. A boulder of granite measured 30 by 25 feet in the deep valley that had been torn out of the loose materials on the side of the mountain.

Passing up this valley the next morning, the 15th, we found an immense number of boulders of Oriskany sandstone, many of them highly fossiliferous. The structure of the formation can be studied admirably from these boulders, which we found to consist of very hard, compact, flinty sandstone containing the fossils, various quartzites, green quartz rock, red indurated clay slate, brown shales, argillaceous seams, and conglomerates. We found none of these boulders higher than the foot of the slide, although others have found them a few hundred feet higher. They came around the west side of the mountain, for none of them were found on top of the mountain, and none upon the east side or in the Basin.

The foot of the slide is 2348 feet above the east branch, and here we find granite in place. There is no difficulty in finding ledges all the rest of the way to the top of the mountain. Here the "tug of war" in climbing commences. The slide is on the steep side of the mountain, and is nearly the steepest possible natural slope of loose fragments. It was so long that while we stood at the bottom our friends at the top appeared to be the merest specks of moving matter, although we could hear their voices very distinctly. The granite along the slide is white, and rather fine grained. The lichens characterizing the colder zone of life, such as the *Lecidea geographica*, first made their appearance at about 3200 feet above the east branch. At the top of the slide we mounted the ridge called the "Horseback," where the vegetation is very scanty. Only a few stinted shrubs and lichens can flourish there. The granite is arranged in plates, resembling strata, running north 30 degrees east, and dipping 50 degrees north-westerly. Soon they change to 70 degrees south-east, as we followed the ridge towards the summit.

Presently we came to the "chimney." This is a steep conical peak rising up suddenly from the ridge, of towards 80 feet in height; but is so steep that we were obliged to assist one another in climbing. We would help one person up a perpendicular shelf, then pass all our baggage, and finally be pulled up one by one. Having gained the top, we found ourselves upon the ridge constituting the highland of the mountain. Its top is undulating, there being several "chimneys" to pass over before finally arriving at the very highest point. We travelled at least three-fourths of a mile along a very narrow ridge, whose top was often only a foot wide, while on both sides of us we could look down for 3,000 feet over precipices too steep to be descended with safety. So awe-inspiring was the sight that some of the party crawled upon their hands and knees over a large part of the distance. We never imagined that in our New England mountains, localities could be found so nearly resembling the peaks and ridges of the Andes. Instantly the idea occurred to us that such a narrow ridge could never have been shaped by drift action. Its sides are covered with those loose angular blocks which frost has removed from the ledges but drift has never transported; precisely like the fragments upon the top of Mount Washington above the drift region. We searched in vain over all the top of Mount Katahdin for any signs of drift action. There are no striæ upon the ledges, no smoothing or rounding of the rocks, and no transported boulders anywhere upon the summit. This view is strengthened by the fact that there are no transported rocks in the Basin, into which an innumerable quantity of boulders would have been hurled if the drift agency had ever crossed the summit.

Only one feature appeared favorable to the view that the drift passed over the top. The whole of the north-west side of the summit appears like one great stoss side, while the lee side is very ragged, just as would be the case if the ice went over the top. But in answer to this it may be said, this apparent stoss side is only the natural shape of the mountain, and its position accidental. This view is partially confirmed by the fact that for a great distance from the summit on the north-west slope no ledges can be seen, only the fragments which have been loosened by frost. Generally, when ledges have been struck by drift, even if the scratches are obliterated, the rocks are not so thoroughly split up by frost but that the rounded ledges remain very slightly affected. This is certainly the case upon Mount Washington. The drift force seems often to have been strong enough to remove all the loose and permanent parts of ledges, leaving the solid foundations so firmly rooted that all atmospheric agencies have not yet had time enough to break them up. We are fully satisfied that a large part of the Katahdin summits have never been swept over by drift, even if we must believe that the highest portion has been struck.

We should not have expressed any doubt as to the freedom of the summit from drift action, if Dr. Jackson had not expressed the opinion twenty years ago that the drift had passed over the summit. We suppose that he must have found some evidence which escaped our notice, although he has given us in his report none of the reasons for his opinions. We quote his remarks on the subject. He ascended the mountain from the west side, in the same path climbed by Mr. Houghton. He says, "Along the whole course of the slide, we found an abundance of rounded diluvial boulders of grauwacke, and compact limestone, filled with impressions of marine shells, showing that the diluvial current once passed over the summit of this lofty mountain." If we understand both Mr. Houghton's and Dr. Jackson's reports, this slide is at the west end of the so-called table land, three miles from the top, and the top of the slide according to Mr. Vose's careful measurements, is only 3,000 feet high, or at least 2,000 feet below the summit. It is not then to be inferred from the fact of the existence of the boulders in the slide, that the current passed over the mountain. As already intimated, the occurrence of these fossiliferous boulders on the slides of the west and south sides of the mountain, and not on the top, shows that the transporting current did not cover the mountain; at least not sufficiently to grind down the rocks as it has done upon lower peaks.*

The granite on top of the mountain is red. The same division of the rock into plates is observed here that we saw on the horseback. They run north 30 degrees east, and dip 65 degrees southeasterly. The red granite caps the white colored rock, very much as one sedimentary rock upon a conical peak caps another of different composition. The mountain, according to the best observation, is 5,385 feet above the ocean, or a little more than a mile high. We regret much that Mr. Vose's Barometer was accidentally broken near the top of the mountain, before he could make any observations with it.

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* From information received since the report was in print, we have reason to believe that we are in error respecting the distance of the slide from the top of the mountain. If the fossiliferous boulders occur near the summit, it is evident that the drift current transported them there. Still the occurrence of a few boulders near the summit will not invalidate our general conclusion.

The general course of the ridge composing the top of Mount Katahdin, as seen from the summit, is that of nearly a complete circle, which is broken on one side. The interior of this arc is called the Basin, and is a beautiful hollow 3,000 feet deep, on one side of which is a pond, directly under the chimney, and for this reason called Chimney Pond. The ridge and the basin together may be compared to a vast crater, only there is no evidence here of the former existence of a volcano. The highest point of the mountain rises quite gradually for a long distance on the west side, hence it has been called a table land: but it is not like the true table lands of South America. It may be called by this name in a loose way, to show that the ascent near the summit is gradual. The west and north sides of this arc of mountains are very much wider than the south-eastern portions.

There are several very prominent peaks upon this curved ridge, only two of which have received distinct names. One is the chimney, which is very insignificant when compared with the nameless peaks, and the other is the highest point, which is Katahdin. There is a very high peak north-east of Katahdin, near the north-east end of the ridge, which has a very broad sloping summit. As this has no name, we venture to suggest that it be called *Mount Pomola*, from the name of the Indian Deity of the Mountains. The Indians formerly supposed that Pomola would be very angry if any person attempted to climb the mountain; hence, like Mt. Washington, the top of Katahdin was considered sacred. The Indian with Dr. Jackson, when he visited the mountain 25 years ago, declared Pomola sent the violent snow storm upon him for presuming to measure the height of the mountain.

After having spent a considerable time upon the summit, the reduced state of our provisions warned us that we must depart, and leave the magnificent view spread out before us, to be exposed a long time, perhaps, before another eye would see it. In comparing the scenery with the view from Mount Washington, we must say that there is less grandeur and more beauty in the view from Katahdin. The immense country to the north and south-east, numerously chequered with lakes and ponds, the mountains of

Aroostook county, of the Canadian boundary, of the region of Moosehead Lake, of south-west Maine, and the White Mountains, are all displayed in distinct outline. Those who love the grand and beautiful should not fail to visit Katahdin, especially as they will find peculiarities here not exhibited elsewhere.

We found the descent into the Basin extremely difficult, owing to the "black growth," or an impenetrable thicket of black spruce, growing upon immense angular blocks of granite. We saw at a distance the bed of snow which remains beneath the summit in the Basin all the year round. We camped for the night at Chimney Pond.

We found the road from Chimney Pond to Katahdin Pond extremely difficult to travel. It was only a spotted line, pursuing a straight course to Roaring Brook, regardless of all topographical features. At Katahdin Pond, Mr. Keep found a single fossiliferous boulder like those on the west side of the mountain; but this may have been brought from the north and not over the mountain, since the same boulders have been found further east and south-east, and the distribution of the sandstone belt on the map shows that boulders of it are to be expected east of Katahdin.

The path travelled by us from the Hunt farm to the top of Katahdin was struck out by Mr. Keep, to whom the State donated a quarter of a township in consideration of his services upon the mountain lands. If a good carriage road could be built from the Hunt farm to Chimney Pond in the Basin, and a good foot or bridle path from there to the summit, an immense number of visitors would be attracted to Mt. Katahdin, especially if a Hotel should be built at Chimney Pond, the most romantic spot for a dwelling-house in the whole State. As the roads are now constructed, it is easier for travellers to ascend from the west branch of the Penobscot, because less time is required away from the water. With the roads thus constructed, travellers would hardly know that they were climbing a high mountain. With the present conveniences, lovers of adventure and recreation will find a trip to Mount Katahdin invigorating, and fraught with pleasure.

We camped near Katahdin Pond on the night of the 16th. On the morning of the 17th, finding our provisions exhausted, we examined two woodman's camps and discovered a supply of beans and flour, which we appropriated, to keep us from starving until we should arrive at the Hunt farm again, where the rest of our party were awaiting our arrival with abundant supplies of fresh salmon and partridges. Early in the afternoon we reached them, considerably exhausted, but rewarded for our exertions by learning that we had completed our tour in the "shortest time on record." After resting over Sunday, we were all ready to pursue our journey up the east branch.

Geology of the East Branch, etc., continued.

On the east bank of the river, just above Mr. Hunt's house, there is a bank of gravel and sand whose strata are inclined at an angle of 25 degrees south, and must have been deposited over a steep slope. Some of the strata are consolidated by a ferruginous cement. At this place we found in boulders of loose sandstone a number of fossils of Lower Devonian type, coming probably from the Devonian rocks above. These boulders are different from those seen on the west side of Mount Katahdin. We suspect the range of mountains west of the East Branch in Nos. 3 and 4, to be composed of trap rock. They have also somewhat of a sandstone aspect.

A short distance above Hunt's farm, in No. 3, the same clay slates that were described below No. 3, occur, running north 10 degrees east, and dipping 80 degrees east. Beyond, the strike is north 20 degrees east, and the dip 78 degrees east. There is a large amount of clay along the river at the mouth of the Seboois. The boulders on the river's banks are now mostly sandstones, conglomerates, honestones and slates, very rarely any of granite. A few miles higher, the granite disappears altogether.

We ascended Lunksoos Mountain on the west side of the river, and found its top to be 1,378 feet above the river, by the Aneroid Barometer. This mountain forms the boundary line between Townships Nos. 3 and 4, and appears to be composed of the same rocks as the range of peaks in No. 3. Lunksoos mountain is entirely composed of trap, a tough variety without any columnar seams. We had a fine view of the country all about this mountain, and in our note book have speculated a considerable about the geological character of the various hills and valleys observed, but will not give these surmises here. We are sure, however, that a mountain five or six miles north-west from Lunksoos, is composed of granite, as we could see the white rocks composing it both from here and Katahdin.

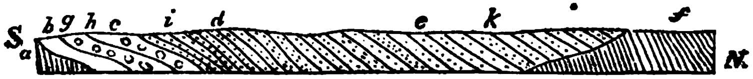
In Number Four of the Seventh Range, the grit rocks dip 60 degrees south-easterly. A similar ledge, called Sufferer's Rock, has strata dipping 65 degrees south-east. At the mouth of Big Spring Brook in No. 5, R. 8, a horseback commences which extends rather more than a mile to Bowlin Falls. Its material is unusually coarse, and boulders of granite predominate in it. Here the strata of slate and grit dip 50 degrees north-westerly, forming an anticlinal with the strata previously observed.

It is proper to state here that we have now arrived at the Grand Falls, which consist of seven different smaller falls, all of which have different names, and are found in a straight line, in a distance of three miles, but more than this if the course of the river be measured. The following are their names, in ascending order: Bowlin Falls, Hull Machine, Grand Pitch, Pond Pitch, Upper Pitch, and Stair Falls, which consists of two parts. The same clay slates and grits at the Hull Machine dip 12 degrees north-westerly. At the Grand Pitch the grits prevail, alternating with thin bands of clay slate, standing perpendicular and running north 40 degrees east. The fall of water here is quite great and very beautiful. Large boulders of conglomerate are common here, such as we shall presently describe in place. The strata of slates above the Grand Pitch dip 54 degrees south-east. Close by the Pond pitch the last of the slates appears, running north-east and standing perpendicular. We think there are two anticlinal and two synclinal axes between Hunt's farm and Pond Pitch, or four anticlinal and four synclinal axes observed in this group of strata above Mattawamkeag. Hence we have crossed the same strata eight times on this section.

At the Pond Pitch trap rock is found in place, which continues to the Upper Falls. In climbing a hill west of the falls we found a few rods thickness of slate and quartz rock before reaching the trap constituting the hill, and which appears to be the continuation of the trap of Lunksoos Mountain. The junction between the trap and conglomerate above was not noticed, but we suspect the trap to be bedded, and related to the conglomerate just as the trap rocks of Perry underlie the Devonian conglomerates and sandstones of that region. In Fig. 13, we have represented the relative positions of the underlying slates, the trap rock, and the coarse conglomerate about to be described.

At the bottom of Upper Falls we are struck at once by the great change in the character of the rock. We find an exceedingly coarse conglomerate composed of pebbles of various hornstones, jaspers,

FIG. 13.



Section of the Devonian Rocks.

a. Clay slate, Silurian.
b. Trap.
c. Coarse conglomerate, base of the Devonian.
d. Fine-grained sandstones.
e. Coarse grained sandstones, top of the Devonian.
f. Clay slates of uncertain age.
g. Pond Pitch.
h. Upper Falls.
i. Stair Falls.
k. Foot of Grand or Matagamon Lake.

slates, and occasionally of granite, averaging two inches in diameter, and sometimes three feet through. Rarely seams of slate, and in one place several feet thickness of a calcareous rock, occur with the pebbles. It is difficult to ascertain the true position of this rock, but we consider the following as the normal one: strike north 65 degrees west, dip 45 degrees north. The same layers are traversed by cleavage planes running north 18 degrees east, and inclined 83 degrees east. We would say more about the different materials of the conglomerate, but our specimens have not yet come to hand. This rock must be about 150 feet thick, and it is evidently the base of the following series of rocks to be described. Very large boulders of fossiliferous limestone abound in the vicinity of the Falls, whose source must be quite near.

Above the Upper Falls, the rocks consist of fine-grained dark-colored sandstones, having a peculiar conchoidal fracture, like clay. On account of the rain, we had no time to stop and examine them closely. At Stair Falls, the ledges cross the river so as to make a series of falls, like a pair of stairs. The strata dip 40 degrees north-westerly, and are composed of sandstones of different textures and colors. Some of the layers contain a trilobite, a new species of the genus *Dalmanites*. At the upper pitch of the Stair Falls, the dip of the strata is a little higher. A little yellow ochre is found in the sand on the banks.

We staid a few days at Johnston's Camp, in the central part of No. 5, R. 8, partly to recruit, and partly to explore the vicinity. At the camp is the finest locality of Devonian fossils we have yet seen in Maine, but the ledges do not appear—the specimens are entirely in loose fragments, whose source must be very near. Our specimens have not yet arrived from the woods, but we remember seeing among the specimens such characteristic forms of the Oriskany sandstone as the *Rensseleria ovoides*. The fossils are entirely marine mollusca. The rock is a loosely cemented sandstone, very much like the Oriskany sandstone of New York, but totally unlike the Oriskany sandstone of Maine. as already described.

A very high range of mountains appeared west of the camp, one peak of which we ascended. Boulders, frequently of enormous size, of red sandstone, are abundant between the camp and the mountain. They are so large that no one can doubt that they came from the base of the mountain. The mountain itself is composed of a beautiful drab colored siliceous slate, weathering grayish white, whose strata at the summit run north 70 degrees west, and dip 40 degrees northerly. This Traveller is the isolated conical peak lying to the north-east of a much higher range of mountains, which has received the same name, but must be nearly a thousand feet higher. This peak is 1,622 feet above the river at its base ; 625 feet below the summit is the lowest level at which the *Lecidea geographica* is found. The same siliceous slates were found at a small pond in No. 5, R. 9, just over the line.

Dr. Holmes made an excursion to the east part of No. 5, R. 8, and found at Horseshoe Pond, in the north-east corner of the township, a large mass of limestone containing the *Favosites Gothlandica* and crinoidal joints, which belongs to the Lower Helderberg group of Upper Silurian rocks. This rock probably crosses the east branch, but escaped our notice in consequence of being covered by alluvium. Its strike is north-east and south-west. There is a small island in the pond, composed of this white limestone, in which there is a cave. About a mile west of the pond, the Doctor reports an enormous boulder of limestone, upon which trees 10 inches in diameter are growing. It is 18 feet high, and 198 feet in circumference. It is on the top of a hill 300 feet above the pond. Between the limestone and Stair Falls, the rocks are fine dark-brown sandstones, somewhat similar to those at Stair Falls.

Approaching the dam at the foot of Matagamon or Grand Lake, in No. 6, R. 8, we find red sandstones, which are still more abundant and bright colored at the dam itself, although black argillaceous seams are found with it. The strata dip 40 degrees north-westerly. Numerous fossil marine mollusca are found at the dam, several of them very large, together with some marine vegetation, while remains of land plants are found further north on the west side of the lake. Our specimens of these fossils have not yet been received. Half a mile below the dam are fossils resembling those collected at Johnston's Camp.

Passing northerly, we find a steep high ledge or mountain, known by an inelegant name, which is a little back from the lake, and proves to be siliceous slate, being a continuation of this rock from the Traveller. Calcite, chalybite or spathic iron, and traces of manganese occur in this slate, often in nodular masses. These slates would seem to be the results of the alteration of the sandstones, unless there has been a great dislocation of the strata, for the sandstone layers do not seem to have been disturbed at all by them. The sandstone is found to continue on both shores about half way up the lake. The most northern strata seen have the strike north 70 degrees east, and dip 15 degrees north-westerly.

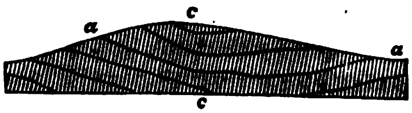
We suppose these sandstones to be the equivalents of the Gaspe sandstones of Canada. There is a very fine opportunity for studying this group, both lithologically and paleontologically, in the region of Grand Lake, and also its connection with the Katahdin rocks. The Gaspe sandstones are 7,000 feet thick. The Grand Lake strata are certainly as thick as the Gaspe, and their stratigraphical relations are given in Fig. 13.

We next come to a class of rocks entirely different from the sandstones, consisting of black slates and slaty limestones, often very much permeated by cleavage planes. We have referred this rock in our map to Silurian in part and Devonian in part, with a very indistinct notion of its proper place. The first ledge of it has the strike of north 55 degrees east, and its strata are perpendicular. The rocks in the neighborhood are very much contorted, while the sandstones are not, just as if the slates were largely disturbed and elevated before the deposition of the sandstones. Further north the slates dip from 45–50 degrees north-west. Numerous small curves are found among them. On Louse Island, the slates dip 42 degrees south, making a synclinal with the strata first observed. The cleavage planes are developed in these ledges at right angles to the strata.

On the south side of Trout Brook Farm in No. 6, R. 9, upon a hill, a hornstone is developed, apparently dipping 45 degrees southerly. The hill appears to be the northern terminus of the Traveller range. It is probably underlaid by the slates just described on Grand Lake, which crop out upon the same hill. The hornstones have a reddish color. Away from the hill, in the low ground, the slates make a gentle anticlinal curve, dipping both north and south, but are permeated very strongly by cleavage planes, dipping everywhere in the ledge 67 degrees north. It is a case similar to that represented in Fig. 14. On the north side of the Farm House, the only planes observed in the rock dipped 83 degrees southerly.

At the south end of the Second Lake, north of the Farm, similar slates abound, dipping both 30 degrees north, and 50 degrees north. The cleavage planes dip 70 degrees north in the same ledges. At the north-west end of the Second Lake, these slates dip 35 degrees north-west, and their cleavage planes dip 80 degrees north. We found here small boulders of red jasper and black hornstone, also others containing Oriskany sandstone fossils. Half a mile up Webster stream these slates dip 40 degrees south-west. Three-fourths of a mile further the rock is a sandstone, probably of the same age with these slates, dipping 70 degrees north-west. Three or four miles above the Second Lake the rock is a beautiful clay slate, dipping 40 degrees south. The cleavage planes run north 75 degrees east, and are vertical. Further on we noticed curves in the strata, but the cleavage planes are perfectly parallel to one another, with same position as before, although the strata in the very same ledges are curved. This fact is shown in Fig. 14. The irregular curved lines, *a a*, represent the strata, and the perfectly straight nearly perpendicular lines, *c c*, represent the cleavage planes. This fact shows that the strata were plicated in this region before the existence of the circumstances under which the cleavage planes were produced. It is very generally the case that the cleavage planes change their positions with the curve of the strata.

FIG. 14.



Cleavage planes crossing strata.

Near the mouth of Webster stream were found boulders of the Lower Helderberg limestone. We travelled in a logging road along Webster stream, and did not see any rocks the last five miles of our route, before arriving at the foot of Webster Lake. Arrived at the lake, we come to the Oriskany sandstone rocks. Consequently we are unable to draw the line between the Oriskany and the slates of uncertain age, nor do we feel confident of their relative position. The Oriskany would seem, however, to pass beneath the slates.

Just above Webster Lake Dam the strata dip about 20 degrees easterly. Then we soon pass an anticlinal, as the next observation gives a westerly dip of 30 degrees, while the cleavage planes dip 75 degrees south east. Before reaching the west end of the lake, the following are the positions of the strata in order: 5 degrees east, 6 to 12 degrees east, 20 degrees west, and 80 degrees north-west, making two anticlinal and one synclinal axis on the Lake. In the last case, cleavage planes dip 60 degrees south-easterly. Near the west end of the lake we began to discover the Oriskany sandstone fossils in the rocks in place, and find them to agree perfectly with the fossils in the boulders scattered all over the settled portions of the State. Among other specimens, we found a most beautiful eye of a *Dalmanites*, a different species from the one obtained at Stair Falls. A large number of angular fragments of rock at the Telos dam contain fossils of the same type. But the ledges upon Telos Lake have furnished the greatest number of fossils. There are several very fine localities on the north side of the Lake, and all sorts of marine life are preserved in the strata. We collected a large number of specimens, and find so much of interest in them, that we shall make them the subject of a separate communication in the spring, in which we hope to describe the new species.

The old maps represented Lake Telos as the source of the Alleguash waters, as was the case a few years ago. But a canal has been cut between Telos and Webster Lake, so that the waters of the Alleguash lakes now flow into the Penobscot, as Webster Lake is 50 feet or so lower than Telos, which is at the same level as all the Alleguash lakes. Moreover, dams have been built at the outlet of Chamberlain Lake, and Churchill Lake, so that practically all the Alleguash lakes water the Penobscot. Really the names Webster Stream, in No. 6, R. 10, and Alleguash Stream, in No. 8, R. 13, ought to be struck out, and the name Penobscot (east branch,) applied to them. The water from No. 9, R. 16, now flows into Penobscot Bay instead of the Bay of Fundy. This change is owing to the skill and energy of the timber owners in this part of the State.

An inspection of the nature of the barriers of Telos and Chamberlain Lakes will at once satisfy every one, as it did all in our party, that formerly the present artificial course was the natural one, and that Telos and Chamberlain, if not Heron and Chu chill lakes, were formed by the deposition of a coarse gravel barrier at

Telos Dam. Could this canal be excavated 20 feet deeper, all the water of Telos Lake would immediately rush out, as Little Sebago Lake did last spring, and perhaps the waters in Chamberlain and to some extent in the other lakes, would follow. There is a rocky barrier, however, in the thoroughfare between Chamberlain and Heron lakes, which would prevent the rushing out of the latter, but would leave them as the sources of the Alleguash river, while the Chamberlain waters would no longer be connected with them.

This case is an illustration of our theories upon a previous page, concerning the former submersion of this continent under the ocean. Upon the former continent Chamberlain and Telos lakes probably did not exist, or were very small. The waters from Alleguash Lake, in No. 8, R. 14, flowed directly to Penobscot Bay. But when the ocean covered up the country, the currents deposited an immense quantity of detritus between Telos and Webster lakes, so that when the country rose again, behold there was a barrier thrown across the old river's course. As this barrier was a very few feet higher than the country between Chamberlain and Heron Lakes, the water of Chamberlain and Telos Lakes was forced to flow into Heron Lake, and thus feed the St. John. This outlet was over rocks, while the barrier was gravelly.

Similar cases have been found in different parts of our Northern States, but generally the process has been carried on a step further than in this example. The new outlet through rocks has been worn down into a gorge, so that the whole lake has been drained. The same erosion would have taken place here if the work had been permitted to go on without interruption for ages to come, and the wearing and draining process would have produced terraces. At present no terraces are to be found on any of these lakes. Hence will be seen the propriety of our remarks upon a previous page, that some parts of Maine had not yet passed through the terrace period.

The cases of this nature in other parts of the North are interesting, because data are afforded us of the lapse of time since the continent emerged from the ocean. This geological timepiece is regulated by the wearing away of the rocky barrier. If a barrier ten miles long has been cut through at the rate of one foot annually, the whole process required 52,800 years, and consequently it is so long since the continent was buried beneath the ocean. We do not give these figures as the true ones, but as an illustration of the manner in which the true figures are to be obtained.

The following is the position of the strata of Oriskany sandstone on Telos Lake, in order, from east to west: 36 degrees north, with cleavage planes dipping 80 degrees south-east; 46 degrees north-west; 75 degrees south-east; 12 degrees south-east; and 80 degrees north; or two anticlinal and two synclinal axes. Upon some of the layers are a great many ripple marks, precisely like those now forming in the sand. In another place a trilobite seemed to have been pushed along over the surface, leaving his trail, but not in a natural way. Many of the strata are very hard, thin-bedded, dark sandstones, with occasionally a few slaty layers. Other layers are altogether composed of slate, and so thoroughly filled with cleavage seams that it is very difficult to preserve the fossils found in them. The fossils are mostly in the vicinity of Point Levy. The south shore of the lake is entirely alluvial.

We come next to Round Pond, or Telosinis, as it is called upon Chace's map. No rocks were seen anywhere upon its borders. From its west side there is a magnificent view of Katahdin, Pomola, and all the mountains of that region. The view is much finer than any from the southern or eastern sides of the mountains.

The last ledge of the Oriskany slates seen in going west is on the south-east shore of Chamberlain Lake, half a mile beyond the thoroughfare from Round Pond. The strike is north 75 degrees west, the dip 20 degrees southerly; while the strike of the cleavage planes is north 75 degrees east, and their dip 80 degrees northerly. We next find an entirely different class of rocks. In describing the rocks upon Chamberlain Lake, we will first describe those upon the south shore, and then, beginning at the north-east point of the lake, describe those upon the north shore.

A little beyond the slate ledge just described, there occurs a conglomerate cemented by argillaceous matter, and not differing very much in appearance from the slates. Its strike is north 60 degrees east, and its dip 60 degrees south-easterly. Pebbles of hornstone and white quartz predominate, and some of them are a foot in diameter. There was a curious appearance in some parts of the ledge. A mass of pebbles of entirely different aspect from the adjacent portions of the ledge are shaped just like a boulder. If we could suppose them to have occupied the place once occupied by a large stone which had decomposed, the idea of their appearance would be clearly indicated. It is possible that they are themselves boulders of a previous conglomerate, which were redeposited in this second conglomerate. In the next ledge the conglomerate is of a darker color, and the pebbles are less distinct, owing to metamorphic action. The strike is north 20 degrees east, and the dip 75 degrees west. Next succeed strata of coarse conglomerate. Succeeding this is a ledge of a compact talcose rock, which is probably an altered sandstone. Upon a small island, which at low water is called Black Point, a coarse trappean like conglomerate appears, dipping 70 degrees east. The trappean aspect is derived from the fact that the pebbles are almost entirely composed of vesicular trap and amygdaloid, also because metamorphic agency has cemented the pebbles together very firmly.

West of Black Point the rocks are concealed for some distance, but when they appear they are similar to the talcose rock mentioned above in the conglomerate, and ledges of them are common for two miles, after which no more are seen of them upon the south side of the lake. Much of it is intermediate in character between quartz rock and siliceous slate, often traversed by veins of hyaline quartz. Some planes in them, possibly of stratification, run north 60 degrees east, and dip 73 degrees north-westrly. We suppose the compact rocks to belong to the same belt as the conglomerates, but are in a metamorphic state. Possibly it is the equivalent of the conglomerate at the Upper Falls. It is more like that than any other rock in the State, and the association of trappean rocks with it is like the state of things at the falls. It differs as much in external appearance from the Oriskany group, as the conglomerate at the falls differs from the overlying sandstone. We seem to have traces of two anticlinals and one synclinal in this conglomerate upon the south side of the lake.

Returning to the north-east corner of Chamberlain Lake, we find the same conglomerate rock, containing many distinct pebbles, although the ledge is largely of the compact variety. At the most eastern point noticed, there are slates dipping 60 degrees south-easterly, which may possibly be upon the east side of the conglomerate. The two rocks here pass insensibly into each other, quite different from the union of a trap and sedimentary rock. The three small islands in the eastern arm of the lake are conglomerate in their character.

Nearly a mile west of the islands, upon the northern shore, we find a slate interstratified with a very beautiful fine-grained sandstone, both very compact, and ringing when struck by a hammer.

They dip 62 degrees north-west. Still further west these rocks appear dipping 23 degrees north, some of the layers being filled with concretions, and very much divided by cleavage planes at right angles to the dip. These rocks extend to the Chamberlain Farm from Leadbetter Brook. They crop out also upon the south shore of Indian Pond, a short distance north of the farm. There the strike is north 57 degrees east, and the dip 22 degrees northwesterly. No fossils have been found in any of these slates and sandstones. We suspect they belong to the Oriskany group. We are confident that the slates at the south-east corner of the lake are the same as those near the farm, for they dip in opposite directions, and both overlie the conglomeratic rock.

The drift striæ upon the borders of Chamberlain Lake are well preserved, and have an unusually east and west direction, as also upon Telos Lake. The country upon the borders of those lakes is covered with the original forest, except an occasional clearing, where the soil is found to be very productive, though often quite stony. There is a fine view of the Katahdin mountains from the Chamberlain Farm.

West of the Farm no rocks were found in place east of the outlet. West of the outlet the rocks are of the same conglomerate character as those upon the south side of the lakes, containing in some of the pebbles a most beautiful amygdaloid. In the Alleguash stream were found boulders of talcose schist, supposed to be the same with the rocks in place.

Leaving Chamberlain Lake we find at the second dam in the thoroughfare, an irregular slaty rock, dipping 37 degrees north-west. It is to be connected with the conglomerate rocks, rather than the overlying slates. Boulders of trap, sandstone, and talcose schist are numerous, just before passing into Heron or Eagle Lake. Opposite the west end of Pillsbury island at the south end of the lake, the rock is trap. The island is probably composed of the same material. We could not cross over to the east side of the lake, where the ledges were quite high and precipitous, but suppose them to be the same. Passing beyond the north side of this island to the north shore, the rock at first sight seems to be genuine trap, but a clear examination shows that it is entirely composed of immense masses or boulders of trap, forming a gigantic conglomerate. They are all very large, the largest being four feet in diameter, and the average two feet. The masses are so firmly united that we hesitated whether to call this rock a conglomerate of pebbles or nodules of trap miscellaneously arranged. The west part of Heron Lake and its islands are also composed of this conglomerate.

Two small islands at the mouth of Soper Brook are composed of trap. One mile up this brook, ledges of a very clear flint rock, or hornstone, prevail. Two miles higher up the brook, specimens of a genuine porphyry were found, probably in a dike, though this is not certain. About a mile from the north end of the lake, a white ledge is very prominent on the east shore, which proves to be siliceous slate weathering whitish. Persons at a distance might mistake it for limestone. At the north end of Heron Lake the rock is a conglomerate, largely made up of vesicular trap and siliceous slate pebbles, very much like the first conglomerates noticed upon Chamberlain Lake. Soon after entering the thoroughfare between Heron and Chamberlain Lakes, the rock is trap, containing epidotic masses. The conglomerate makes its appearance about a mile from Heron Lake, weathering white, which has in it pebbles of trap, quartz rock and siliceous slates. Its strata dip 40 degrees north-west.

A dark sandstone, almost a quartz rock, occurs upon an island at the south end of Churchill Lake, dipping 30 degrees south-westerly. Drift striæ upon it run north 55 degrees west. The shores of the lake are generally low and alluvial. Near its upper end, a range of mountains crosses our course, and they look as if they were composed of trap, though it is impossible to judge certainly of their composition without personal examination. For the first time since leaving No. 4, we find at the north end of Churchill Lake a quantity of granite boulders, but they are seen only for a short distance. Judging from the direction of the striæ, these boulders were derived from the north-west, probably from the mountains in No. 10, R. 13. A short distance below the Dam, ledges of clay slate appear, dipping 62 degrees north-west.

No ledges were then seen until we came to Umsaskis Lake. The Alleguash river is full of large boulders of schist and trap, altered slates, and a few of granite all the way to Long Lake, a distance of ten miles. Between the two lakes the river winds among hills, but the valley is much wider at the Lower Lake. About the middle of Umsaskis Lake a clay slate ledge appears, at a distance resembling an unstratified rock, whose strata run north 80 degrees east, and are perpendicular. No other ledges were seen as far as the Depot farm at the foot of Long Lake in No. 12.

The region between No. 12 and the mouth of the Alleguash river was explored by Dr. Holmes, and his specimens were examined by us. They are all of clay slate, sometimes of almost roofing slate quality, and sometimes calcareous, and again a little micaceous. Four miles above the Grand Falls, the clay slate runs north-east by north. At the Falls, the strata dip south south-east. Still further down the dip is 70 degrees south-east.

We found clay slate on the road between the Depot Farm and the Seven Islands Farm, dipping 66 degrees south-east, near the line between the fourteenth and fifteenth ranges of Townships. The country is undulating and thickly wooded. The first ledges of talcose schist seen were about five miles east of the St. John river.

Some have preferred to use the Indian names for some of the Alleguash lakes. Chamberlain Lake was called Apmoogenegamook, Heron Lake was called Pomgokwahem, and Churchill Lake was called Woolagasquigwam Lake.

The conglomerates, siliceous slates and trap rocks upon the Alleguash lakes, are represented upon the geological map as trappean and altered rocks. In a final map this heading would be subdivided into three parts. Everything below Churchill is represented as clay slate.

The country from Seboois River to Masardis.

Dr. Jackson left a few notes upon this interesting region in his report, and Dr. Holmes published also some of his observations in the vicinity about the same time, from which we have prepared the following brief outline, deeming it desirable to present the prominent features, using our own nomenclature.

The Seboois river joins the East Branch of the Penobscot in No. 8, R. 7. At its mouth the banks are alluvial. The rock first seen is the clay slate series, which on the east branch we found to extend as high as the Pond Pitch. This extends to the upper part of No. 4, dipping 80 degrees east. Peaked Mountain in this township is composed of a conglomerate, probably a part of the series we found between the Grand Falls and Grand Lake. Large beds of limestone containing the *Favosites Gothlandica*, which are probably the Lower Helderberg series, are also found about the mountain. The mountain has been cut through by a huge mass of trap, which has produced changes on the adjacent strata. The southern peak is composed of amygdaloid and hornstone. This we suppose to be the same with the trap below Pond Pitch. The central peak is composed of coarse conglomerate traversed by veins of calcite. Boulders of red sandstone are found on the surface. The top of the mountain is 660 feet above the river.

Above this mountain, the river finds its way among precipices of sandstone, 200 or 300 feet high. At the mouth of Jerry Brook, on the west bank of the Seboois, in No. 5, R. 7, red sandstone appears, dipping 75 degrees south-east. Sugar Loaf, on the east side of the Seboois, 1,900 feet high, is composed of sandstone and clay slate cut through by a dike of trap 500 feet wide. The slates adjacent to the trap have been changed into jasper, hornstone and compact feldspar. Nodules of calcite and epidote occur in the amygdaloid part of the trap. The jasper bed is 10 feet wide.

At Chegalapscagos Falls, red slate rocks are found, dipping north-westerly 80 degrees. Above the falls numerous dikes of trap rock, and masses of jasper abound. Large boulders of the fossiliferous Helderberg limestone are also found in the vicinity. In the south part of No. 6, the red slates dip 60 degrees N. W., then to the S. E., and presently to the N. W. again. At Godfrey's Falls, which we conjecture to be in the middle of No. 6, the rocks are slates. Near the First Seboois Lake in No. 7, there is a fine development of the Lower Helderberg limestone. It is 90 feet wide, a bed inclosed in sandstone and brecciated by the intrusion of scoriaceous trap. Encrinites and the common favosite coral abound in the rock. Some parts of the bed are described as a good marble.

The rocks upon the Third Seboois Lake are argillaceous limestones, sandstone and trap. No rocks are observed upon the La Pompique stream.

Dr. Holmes, in passing from Matagamon Lake, on the East Branch, up Hay Brook, found perpendicular seams running through slate, with an east and west direction. About a mile above the mouth of the Mooseluck stream, in No. 8, R. 8, he found a ledge of coarse conglomerate.

Eight miles below the mouth of the La Pompique, on the Aroostook, strata of calciferous slate occur, dipping 50 degrees S. E., and containing beds of limestone. For miles lower down the rocks are clay slate, dipping 30 degrees N. W. This is in the west part of the Oxbow plantation. In the south-west part of Masardis, slate and quartz rock occur which we suppose to belong to the

Oriskany sandstone. In Masardis, half a mile above the village, limestone appears dipping 40 degrees S. E. Other ledges of limestone crop out before we reach Ashland, where it is probably connected with the Helderberg limestones already noticed. Opposite the mouth of the Big Machias river are the fine grits of doubtful age already noticed.

Region of the St. John River.

The highest point on this river to which we ascended cannot be far from the north line of No. 11, R. 16. The rock is talcose schist, dipping 61 degrees N. W. This rock extends on the river as far as the mouth of Great Black river. The next rock measured was on the line between R. 15 and R. 16, and the schist dips 67 degrees N. W. Small beds of clay slate are occasionally associated with the schists. A couple of miles farther down the river, the schists dip 75 degrees N. W., 75 degrees S. E., and stand on their edges. Joints cross some of these ledges, very much like cleavage planes. In the south part of No. 13, R. 15, the schists dip 75 degrees N. W. At the time we ascended the river the water was very low, and we found great difficulty in travelling. Large boulders of talcose rocks, some of them 10 feet in diameter, are common the whole distance above the Seven Islands. The country is very low, so that we could see no hills on either side. The soil is excellent wherever any meadows line the banks, and of an ordinary character away from the alluvial patches. As to the prospect of finding gold on the Upper St. John, we have already spoken.

The Seven Islands are all covered with rich alluvial soil, so that enormous crops are gathered from them. Mr. Cary's farm is in fine order under the management of Mr. Currier. Below the farm some distance, the talcose schist dips 61 degrees S. E. There is an immense boulder of conglomerate in No. 13, R. 14, showing that rock to be in place at no great distance. In No. 14, R. 14, we find crystals of mica in the so-called talcose schists, which have been crystallized since the consolidation of the rock. This fact illustrates our previous statement that there is no talc in talcose schist. An analysis of this rock would be very desirable.

We begin to find the ledges with glacier striæ, the force having very evidently been directed down the valley. Upon the ice side of one of these ledges, we noticed two pot holes, each about two feet across. They have been worn out by the current of the river, perhaps before the glacier existed. The details of the traces of this ancient glacier have already been described.

Near the McCrillis farm the ledges dip 80 degrees south-easterly, and there is a mineral spring. Near the farm the rocks become more slaty. All along the river the rocks crop out in abundance, and the general character of the river is the same as that above the Seven Islands, but the hills are increasing in size constantly, so that high mountains press close to the river about the mouth of Black River. There is more meadow land at the farm, but scarcely any in the country between Cary's and McCrillis' farms. Below the latter farm the rocks are still schists, but are slightly argillaceous. At the second great bend in the river, before reaching the Big Black River Rapids, clay slate appears. As it were, the river passes just to the junction between the schist and the slate, and then turns and flows over the shists again. These slates appear to be nearly horizontal, with cleavage planes dipping 70 degrees north-westerly. The discovery of these cleavage planes awakened the supicion that possibly all our previous observations related to the cleavage planes, and that the marks of stratification have been entirely obliterated. If any stratified planes had been present in the schists, we should not have overlooked them, as we kept a sharp lookout for all differences of this nature.

The valley is very narrow along the rapids, and is completely filled with boulders. Among them we found masses of red slate, red sandstone, vesicular trap and various quartz rocks. Some beds of clay slate are found in the schist in No. 16, R. 13. In the vicinity we find considerable alluvial conglomerate. There appear to be two anticlinal and two synclinal axes in the talcose schist thus hastily examined. In No. 16, R. 12, are boulders of dun colored quartz rock, calcareous rocks, red, green and dun colored sandstones, besides various slates. The first alluvial clay seen is in No. 16, R. 11.

The clay slate begins as a formation at the great curve in the river three miles above the mouth of Little Black River. A mile and a half further its strata dip 65 degrees north-west, and presently change to 60 degrees south-east. Then it changes again to the north-west dip. Good roofing slate may be found on the west bank of the river a short distance above the mouth of Little Black River. Presently small beds of limestone appear between the layers of slate. We learn from Mr. Samuel Bolton, that between the two Black Rivers, four or five miles west of the St. John, there is a large amount of limestone.

As soon as we arrive at the mouth of Little Black River, we see a number of beautiful terraces, which extend from this point to Woodstock, with scarcely any interruption. The Acadian French settlements commence here, continuing to the Grand Falls, in New Brunswick. The scenery all the way is very fine. Near the mouth of the Alleguash River the rock is talcose in appearance. A mile below the rock is genuine talcose schist. It is of limited extent, however. The dip of the clay slate below is 70 degrees north-west. Still further down the clay slate has the strike north 20 degrees, and an easterly dip of 40 degrees. The cleavage planes are both perpendicular, and dip 60 degrees east. Every exposed ledge is covered by all kinds of striæ, glacial, drift, and fluviatile. At the Great Rapids the clay slate strata dip 53 degrees north-west, and the cleavage planes 80 degrees north-westerly. This is a beautiful example to show the difference between the planes of stratification and cleavage in the same ledge. It should be stated that this clay slate below Little Black river is more sedimentary in its character than ordinary clay slate. It might with equal propriety be styled fine grained sandstone.

Dr. Holmes went up the St. Francis river to the boundary line, and his specimens from the route are all clay slates, the central portion of which are somewhat calcareous. Six miles below the mouth of the St. Francis river the same distinctions between the strata and cleavage planes are observable that we have specified above. At the village of St. Francis the strata dip 20 degrees east, while the cleavage planes are perpendicular. At Fort Kent, we went back a few miles from the river, and found boulders of Laurentian gneiss, which must have been brought from the north side of the St. Lawrence river, a distance of more than a hundred miles. One of the boulders is 12 feet long. About 400 feet above the river we found what appear to be ancient sea beaches, skirting the sides of the hills. Wallagrass plantation is entirely underlaid by clay slate.

In the east part of No. 18, R. 6, the cleavage planes of the clay slate dip 64 degrees north-westerly. It is probable that the strata coincide with them. Further on the dip of the strata is distinctly 45 degrees easterly. Half a mile before reaching the great bend in the river in No. 18, R. 5, or Dionne, the clay slates dip 30 degrees south-east, and the cleavage planes 75 degrees west. At the mouth of the Madawaska river the slates are more shelly and easily decomposed, in consequence whereof the valley becomes much wider. The view from the high land at the mouth of the river is very fine. Several beds of blue clay are found in Great Isle plantation. One of them contains fragments of fossil wood, which are completely penetrated by a beautiful blue earthy phosphate of iron. Dr. Jackson found a fossil Unio buried in this clay; also slate suitable for roofing three miles above the mouth of Green river. About four miles above the Grand Falls the clay slate dips 30 degrees north-west. This was the last ledge of clay slate seen. According to our observations we have passed over four anticlinal and four synclinal axes in this belt of clay slate. The section is very transverse, however.

The next formation we cross is full of small undulations of the strata. So numerous were they that we tired of recording them. The rock is a mixture of obscure slates and limestone, or the calcareous slates of our map. At the Grand Falls there is an anticlinal in the strata, the two sides dipping north-west and south-east. There may have been a dislocation of the strata also at this place. We have here another example of the change of the course of a river in consequence of the obstruction of the old course when the continent was under water. The village of Grand Falls is built upon a high terrace composed of gravel, which is fifty feet higher than the water at the head of the falls. As the water did not rise high enough to remove this barrier it was compelled to run over ledges, and has since the elevation of the continent been obliged to wear out this crooked gorge from the solid rocks. All the lumber and produce brought down the river must be carried across this high gravel hill. We wonder that this village could have been built for so long a time within three miles of the United States, and that no Yankee has yet discovered that the construction of a canal across this bank would be a most "profitable investment."

A mile below Grand Falls, the calciferous strata dip 10 degrees easterly, and several large dikes of trap are adjacent to them. The following are the positions of the strata observed below; 40 degrees westerly, perpendicular, easterly, and at a great bend in the river there is a small inverted anticlinal, the west side being nearly perpendicular, and the east side dipping 30 or 40 degrees east. Other curves might be specified, were it desirable. Below the mouth of Salmon river the strata dip 65 degrees south-west, while the cleavage planes are vertical. From the mouth of the Aroostook, we went to Presque Isle, and found the same calcareous rocks all the way. At the mouth of the Aroostook, these slates run north 75 degrees east, with the dip of 30 degrees northerly. There is probably an old course of the St. John river from the Grand Falls to the Aroostook Falls. We found here boulders of amygdaloid and conglomerates. Below Tobique village the limestone is scarce, and the slates dip 60 degrees north-westerly. Some of the strata dip 19 degrees southerly, and it is possible that the first observed position is that of the cleavage planes. More limestone is found at the River des Chutes. Boulders of Lower Helderberg limestone, containing fossils, are found in the vicinity. Four miles below this river the strata are largely calcareous, and are perpendicular. Trap dikes appear before reaching Florenceville. At this village, slates and limestone alternate, and stand mostly perpendicular, and are very irregular. The various positions of these calcareous slates show us what may be expected in the same strata in Maine, where their general position appears so uniform. A careful examination of the St. John rocks will throw more light upon the rocks in Maine, than we can obtain by very protracted examination of her strata near the line, because the river exposes the ledges so well.

About nine miles above Woodstock, at a ferry, red sandstones and conglomerates appear on the river's banks, dipping 25 degrees north-west, and form a belt half a mile wide. Some of the strata are very fine grained, and we find upon them the prints of raindrops which fell hundreds of thousands of years ago, when these layers were part of a clay bank upon the beach. The clay became hardened by the sun before the next layer was deposited upon it, and consequently we have preserved both the impressions made by the drops, and the little protuberances from the upper layer filling up the small depressions. Most of this rock is a coarse conglomerate. Some of the pebbles are encased in gypsum. Without doubt it is the same rock as the conglomerate on Tobique River, where gypsum is found. It may be that this rock extends into Maine. An examination should be made to determine this point, for if a gypsiferous rock occurs in Maine, gypsum may be found in it, and be of incalculable value to the farmer.

No more is seen of the calcareous slates. In their stead, upon the south side of the gypsum rock, is a very hard quartzose rock, dipping 70 degrees westerly, thus underlying the conglomerate unconformably. Similar quartzose rocks are found all the way to Woodstock. Some of them in sight of the town dip 50 degrees north-east. In the village, at a brook, these rocks are very evenly bedded, and remind one very much of the older silurian rocks. They dip about 25 degrees north-westerly. These rocks ought to be investigated fully on account of their relations to the copper bearing rocks which may run over into Maine.

Here the exploring party broke up. But three of us crossed to St. Andrews, and can say a word about the rocks between Woodstock and St. Andrews. The rocks are mostly covered by drift between Woodstock and Canterbury station. Those that appear are obscure mica schists, resembling siliceous slates. Three miles north-west of the station, there is an argillo-micaceous slate, occasionally calciferous, dipping 65 degrees north-west. A large block of jasper was noticed, indicating that it is found in place to the north-west, perhaps in Maine. Other boulders were of granite, containing green feldspar.

Fine beds of peat and marl are found at Canterbury station. This is an interesting fact because it makes it probable that marl will be found lying upon these same rocks on their extension into Maine. The rock a mile south of the station is mostly limestone, but belongs to this micaceous formation. For most of the first 27 miles between Canterbury and St. Andrews, granite is the prevailing rock. At the McAdam station, Mr. Edward Jack, the gentlemanly Land Agent of the Q. and St. A. Railroad, pointed out to us a horseback upon the side of the track, which is five miles long. 26½ miles above St. Andrews, clay slate is seen upon the side of the road, and extends for seven and a half miles. The next thirteen miles of the route are occupied by trap rock, which frequently forms very steep mountains. The last six miles above St. Andrews are underlaid by the red Devonian sandstones and conglomerates, which extend across the Passamaquoddy bay to Perry. Interesting vegetable remains occur in this sandstone in St. Andrews.

The next region to be noticed is the country around the large lakes in the north-east part of Aroostook country. Their exploration was assigned to Mr. Packard, who has made out the following report concerning them.

To C. H. Hitchcock, *State Geologist.*

Sir:—I send you herewith, a report of my observations upon the physical and geological character of the country about the Fish River Lakes and the Aroostook river between Ashland and Presque Isle.

Yours truly,

A. S. Packard, Jr.

Brunswick, Dec. 1, 1861.

Fish River Lakes.

"After leaving you at the Seven Island Carry on the Alleguash, according to your directions, with A. B. Farrar as waterman, I hastened down the St. John River to Fort Kent, and after laying in enough provisions, started down the river on the 10th September. Two or three hours' paddling took us twelve miles, to the portage over on to Cleaveland or Long Lake. Placing our canoe and baggage upon a Frenchman's car, we left the fertile and pleasant valley of the St. John for what we supposed a rough logging road. We found that the portage of four miles lay over a very fair road, with farms belonging mostly to the French, all the way to the lake. The rock when it once cropped out, was the dark slate that we left on the St. John. The soil, composed of slate drift, was light and fertile, nearer the lake dark and loamy, producing good crops of wheat and buckwheat, just then being harvested. The forest consisted mostly of hard wood growth, especially the sugar maple, which surrounded the lake. Coming out on to the lake about three miles from its head, where another road comes in from the Madawaska settlements on the St. John, we found on the east side several farms newly cleared, while for three miles down along the west shore were farms sloping down to the water's edge from the fine maple forests back of them. A mile below the portage, the rock was a dark slate with a perpendicular cleavage dip, striking west south-west, and east north-east. A little farther on, the slate was more reddish, but no stratification was apparent. Two miles farther on, at a point where the lake bends around to the west, the slate was hard and gritty, with the same cleavage dip and strike. Across the lake, at two points east and south, were hard slates with bands of grit, running west south-west, and east north-east, by compass, with a dip of 60 degrees north-west. The cleavage was nearly vertical, and its strike the same as that of the strata. It was also more hilly here, and more fir and spruce in the forest. Passing the next day through the thoroughfare into Mud Lake, where is an old weir made by the Frenchmen to catch togue, trout, and white fish, we found no ledges, but a low flat cedar swamp on the north side of the lake, and on the south side hills of slate, apparently, from their contour. The two mile thoroughfare into Preble or Cross Lake, and the lake itself, was but a repetition of Mud Lake. There was no exposure of rock, the country hilly upon the south side, while the land opposite, or that lying around the head and sides of the lake was low and wooded with spruce and cedar. The south shore consisted of a narrow beach of grit and slate pebbles. Another thoroughfare of half a mile, where we found a large angular boulder of a dark green tough sandstone, brought us out on to Lake Sedgwick, or Square Lake, as it is commonly called. This is the largest of the first four Eagle Lakes. It is about eight miles long, and two miles across, lying north and south. The country about the head is rather hilly, while its foot is by a thoroughfare of about four miles connected with the Eagle Lake. Various points run out into the lake, with beaches of silicious pebbles, which at a distance look like ledges of slate. On the east side, a mile below the thoroughfare, was one low slate ledge, but so cut up by cleavage that the direction of the strata or their dip could not be ascertained. The only other ledge was a mass of grayish white limestone, rising out of a low sandy point on the west side, three miles from the foot of the lake. I had been informed previously, by gentlemen at Fort Kent, also by the people on Cleaveland Lake, that lime has been made here. The mass of rock was about twelve feet long and eight feet high, with large fragments scattered around in the sand. A Frenchman told me that pieces were strewn over the bottom of the lake for a mile along and near the shore. The rock, a white and gray limestone, the white portion rather coarsely crystalline, the gray portion more compact, with some silex, in the mass was of a somewhat oolitic, concretionary structure, enclosing small distorted layers of reddish slate, and occasionally a small quartz pebble. It abounded in fossils.* A half a day's work gave us a species of *Cyathophylloid* coral, a *Fenestella*, numerous *Crinoidal joints*, and two heads of encrinites; an impression of a large *Lingula*, four species of *Atrypa*, six of *Leptaena*, with three other species of *Brachiopoda*; two *Gasteropoda*; with the heads and abdominal segments of three species of Trilobites, two of the *Calymene* type; the other a *Brontes*. These same fossils occurred in large fragments of a brown slate that had been dug out of the sand, and had been used in the construction of two rough kilns, where Pascal Longley for four years has burnt lime after the spring sowing time, and after harvest in the fall. The last year he burnt sixty barrels of a very good quality of lime, selling it at $1.50 per barrel on the spot, or carrying it twenty miles in flats over to the settlements on Cleaveland Lake, sold it there for $2.00 per barrel. No doubt after this supply of limestone has been used up, farther exploration around the lake will reveal larger deposits.

The thoroughfare into Eagle Lake at its commencement, run with quite a current over a shallow pebbly bottom, on which our canoe sometimes hit; but for the last mile, the banks were fifteen to twenty feet high, and very regular, and we passed by several clearings made by lumbermen. This even regular bank extending out into the north side of the lake for nearly two miles, was caused by a soft, crumbling, brown slate, or shale, with their beds of grit running south south-west, and east north-east, dipping north-west 35 degrees. Standing out from this rock and from the bank, were masses of a dark brown limestone conglomerate, with pebbles of dark slate, and occasionally little pieces of a green mineral, probably carbonate of copper. The slate had a little iron scattered through it in thin lamellæ. A mile farther on, a band of sandstone rested upon the shale, and upon this, opposite the thoroughfare into Long Lake, and at the point where the Eagle Lake bends around to the north, was a high bank of a light slate, dipping 45 degrees to the northward, which soon passed into the dark clay slate that forms the hilly country about the foot of the lake, fifteen miles from the St. John River. Eagle Lake is eighteen miles long by two miles wide. The south side is low and covered with spruce and cedar. Its western and northern side more hilly, with a fine hardwood growth. The Fort Kent road that runs six miles along the side of the foot of the lake, is settled for the most part by the French.

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*This rock is the Lower Helderberg limestone. A notice of the fossils will be found on page 240. C. H. H.

The south branch of the Fish River empties into Eagle Lake by a thoroughfare of two miles, at this time with just enough water for a canoe. On each side, the interval land is rich. In several places it has been cleared of elm and maple trees and laid down to grass lands, or where the shores were higher, cleared for farms. At the upper end, the Fort Kent road crosses by a good bridge the river, which runs out from Long Lake a few rods above. At some distance below the bridge, the southern shore consisted of a soft crumbling conglomerate, the same as on Eagle Lake, which in regular strata, striking west south-west, and east north-east, dipped 35 degrees toward the north. At the bridge, the red shale which formed the bed of the stream, rose on the northern side into a bluff, with thin beds of grit, and patches of sandstone interstratified, all somewhat disturbed, dipping 45 degrees—60 degrees north, with a general east north-east direction. The hill back of this bank was underlaid by a gray slate containing cubes of bisulphuret of iron. Coming out on to Long Lake, the shores were low, lined with cedars, and farther out with rushes, where we saw for the first time two muskrat houses.

On the west side, two miles up the lake, the rock was a dark clay slate, which towards the head of the lake passed into a dark hornstone. While opposite, the shore though a little way back rising into hills, over which the Fort Kent road runs, consisted of a crumbling conglomerate, with patches of sandstone, dipping 20 degrees northward, with the usual east north-east strike. On both sides of the lake, at its head, were ledges of a dark tough hornstone, which apparently formed the hills around, which were thickly wooded with a hard wood growth. The thoroughfare of ten miles, running out of Portage Lake, is at each end dead water, while in the middle it is rather quick and shoal, spreading out around small islands. We noticed small beds of river clay, which may be found in greater abundance, suitable for brick making.

Coming to the quick water a little more than half way through the thoroughfare, where the bank is rather high, we found a ledge of limestone and conglomerate, with red shale like that met with before. First a bed of fine limestone conglomerate about a foot thick, the limestone cement wearing away, leaving the gritty gravel sticking out from the surface; next a thick bed of light limestone conglomerate, with a few crinoidal joints, and under this a dark fine-grained limestone, with seams of calcareous spar. These beds were underlaid by the red shale, interstratified with their beds of grit, all striking east north-east, with a dip of 60 degrees northward. Here is good lime for burning, and in a very accessible place; it can be boated up or down the thoroughfare to the settlements on the lakes at each end at very little trouble. For two miles on, the strata ran across the river. Where the rock was soft, the stream was sluggish; but where it ran over the gritty bands, it ran rather swift and shallow, and our canoe bumped sadly upon the rocky bottom, and gravel beds, being in some cases ancient beaver dams, which lay across the stream.

Portage Lake has no ledges upon it; its foot is surrounded by a low cedar-covered country, with two flat islands. On the south side fine farms slope down to the edge of the lake, and back of them is a heavy growth of deciduous trees. The hill on the south shore was of a dark brown hornstone.

It was our plan to carry from Portage Lake two miles over to the lake on the head of the Little Machias, and descend that stream to Ashland, but the water was too low to render that possible. We therefore had our canoe placed upon a wagon, and so carried down to Ashland, on the 18th September. The Fort Kent road runs for ten miles from Portage Lake into Ashland over a rolling country, with no rock exposure. In the afternoon, with Rev. Mr. Keep, we visited, just on the outskirts of the village, near the junction of the Great Machias and Aroostook Rivers, a locality where limestone had been dug out for burning. It was the same kind of gray limestone that we had found on Sedgwick Lake and on the thoroughfare into Portage Lake, and occurred with the same kind of red slate. In the limestone was an abundance of a Favosites-like coral, and crinoidal joints, and in the shale a species of *Leptaena*. We were shown a piece of quartz with some gold which had been found up the Aroostook River. The region about the head waters of the Aroostook is clay slate, and no doubt of the same age (silurian) as those rocks in Nova Scotia which are gold-bearing, so that proper search may reveal deposits of that mineral.

The want of sufficient water prevented our ascending the Great Machias, as we had hoped to do, so on the morning of the 19th, we started down the Aroostook for Presque Isle. A mile below

Ashland, on the north side of the river, was a bluff of red shale, dipping 60 south-east. On the same side, three miles farther down, was a high ledge of fine dark limestone, with beds harder and finer running east and west, dipping south 35 degrees. Farther on, upon the same side, occurred a very coarse dark conglomerate, with gritty slates dipping 35 degrees south, large fragments of which filled the bed of the river some distance below.

Five miles below Ashland, on the south side, is a high perpendicular bluff of a light gray, hard, coarse grit, with fucoids, in layers about a foot thick running east and west, and dipping gently 10 degrees south. A mile above Salmon Brook, we visited on Mr. Hickey's farm, elevated over a hundred feet above the river, a locality of iron ore, which occurred in strata running a little east of north, and dipping slightly south-east. No attempt has been made to work this valuable deposit of ore. The bank of the river here is made up of a dark limestone, with harder bands, and streaks of calcareous spar in much disturbed strata, running north and south and east and west at the mouth of Salmon Brook, dipping slightly to the southward. For the remaining ten miles to Presque Isle River, the country is better adapted for farming; there is less black growth and more interval land, and there is no rock exposure, so that our exploration was here ended."

We would add a single word respecting the rocks between Ashland and Presque Isle upon the carriage road, which is nearly parallel with the river. The Devonian sandstones and conglomerates within the limits of Ashland have already been noticed. Near Castle Hill, there is quite a wide belt of calcareous slates running north 15 degrees east, and dipping 70 degrees westerly. No rocks occur in place east of these till we come to Mapleton, when we find the Devonian red sandstones in the west part of the town, dipping 40 degrees southerly. In the south part of Mapleton, we examined strata of red and gray sandstones of the same age, dipping 45 degrees west. We found none of the sandstones in Presque Isle. There the calcareous slates prevail.

Finally, we present an account of the geology of the Moosehead Lake region, prepared by Mr. Houghton, who explored that district in company with Mr. G. L. Vose of Boston.

To C. H. Hitchcock, A. M., *State Geologist of Maine:*

Sir:—I send you herewith, a report of the observations made in accordance with my instructions in the survey of the section assigned me, embracing Brownville, Katahdin Iron Works, Moosehead Lake, and the west branch of the Penobscot river.

Yours truly,

John C. Houghton.

Bangor, Nov. 26, 1861.

According to my instructions, I commenced the survey of the section assigned me, by the examination of the slate quarries at Brownville, Monday, August 19th, 1861. These quarries are two in number, and are in the same strata, distant from each other about one mile. The dip of the strata is 72 degrees north, strike north 80 degrees east.

The eastern quarry is owned by a company in Bangor, whose Superintendent, Mr. C. H. Crocker, kindly furnished me the following statistics:

"The average amount annually taken from our quarry, for the last five years, has been about 10,000 squares; but we are now preparing to increase our business considerably, and shall probably produce 12,000 to 15,000 squares, the coming season.

Cost per square, on the bank, inclusive of wear of machinery, $2.50.

Cost per square, for transportation to Bangor, $1.50.

Value at Bangor, per square, $4.50 to $5.

Profit, per square, 50 cents to $1.

The yearly quantity of "slab slate" varies very much. We sell it, per foot, at 25 to 50 cents. Cost of planing, per foot, 12 to 16 cents.

The width of the quarry north and south is 250 feet, which is as far as the good slate extends.

Depth worked at present, about 90 feet.

Rubbish removed from the top, 15 feet."

The west quarry is owned by Mr. A. H. Merrill, to whom I am indebted for the following statements:

"I have spent, in opening and preparing machinery for working this quarry, $75,000. Have quarried annually from 2,500 to 8,000 squares.

Cost per square, on the bank, exclusive of wear of machinery, from $1.50 to $2.

Transportation to Bangor, $1.40 to $1.50.

Value at Bangor, per square, $4.50 to $5.

Profit, per square, interest of capital out of account, $1 to $2.10

Width of the quarry north and south, 200 feet.

Depth now worked, 80 feet.

Rubbish removed from the top, 15 feet.

The removal of this rubbish is attended with great expense, as it is mostly slate rock of poor quality, and is one of the greatest difficulties encountered in working the quarry. The good slate is found in layers, varying in width from six inches to nine feet, and alternating with hard and worthless rock, the layers of which are from two inches to four feet wide."

The strata, in which the quarries are, have been traced from the quarries east about three miles, where they are lost in a swamp and pond. To the west, they can be traced but a short distance, on account of the depth of the superincumbent soil.

The only advantageous positions for working them have been taken by the parties now engaged in the business, their quarries being on opposite sides of the valley of Pleasant river.

There are several places in Brownville and adjoining towns, where openings have been made, in hopes of being able to work the rock for roofing slate, but all have proved in vain, on account of its hardness. There are, however, two places, about 100 and 175 rods north of Mr. Merrill's quarry, where there crops out as good slate as any in the region, but its extent is not known, on account of the overlying rubbish. The height of the ground in front of F. W. Brown's house in Brownville, is 438 feet above the sea, and 117 feet above the level of the Piscataquis river at Foxcroft. For the elevations I may give in this report, I am indebted to Mr. G. L. Vose of Boston, who reduced them with great care from the barometric work by the mean of the greatest possible number of observations.

In the afternoon, I rode to Katahdin Iron Works, which are about 18 miles north of Brownville. The same formation of siliceo-argillaceous slates, which extends from the granite region of Frankfort to the granite of the west branch of the Penobscot, embraces all the section about the iron works and affords but little variety to the explorer. The dip of the strata is nearly perpendicular, varying from 70 degrees north to 70 degrees south, with a strike north 50 to 80 degrees east. The valley of Pleasant river affords many admirable situations for farmers, as the thrift of many of that occupation in Brownville fully proves.

The land along the river is easy of cultivation, and well repays the care bestowed upon it, while the hill-sides skirting the valley being well watered and fertile afford excellent pasturage, good evidence of which is seen in the fine cattle that are raised in that vicinity. The last eight miles of the road to the iron works are very rough and hilly and lead through a forest of young growth, consisting principally of white, black and yellow birch, ash and rock maple, interspersed with hemlock, spruce and cedar. In the low grounds arbor vitæ, swamp spruce, alder and viburnum are abundant. In the latter part of the afternoon, I had a short time in which to explore

"*The Katahdin Iron Works.*"

These are situated in the valley of the west branch of Pleasant River, and consist of a furnace, a mill for rolling iron, a large building used as an office, and eight or nine dwelling houses, including a fair and commodious hotel.

The iron business is now entirely suspended, and the furnace and other buildings are sadly dilapidated. None are occupied, except one dwelling house and the hotel, which is kept open by Mr. J. Pollard, for the accommodation of lumbermen in winter, and tourists in summer.

The natural situation of the place is very romantic, being in the midst of high mountains, of which the Ebeeme, Saddle Rock, White Cap, Sugar Loaf and Ore Mountain are of chief interest. In the basin, formed by these mountains, are two very beautiful ponds—one, that through which the stream above mentioned flows, being very near the hotel, and affording to visitors excellent opportunity for boating or fishing. The Indians called this pond the Mummyrungin, but from the great quantity of water lilies, (*Nymphœa odorata*, Ait.,) that are found in one part of it, it has received the more civilized name of "Lily Pond." The "Ore Mountain" is about 1 1-2 miles west of the furnace, and on the north side of this is the "ore bed," a deposit of bog iron ore of unknown extent, and averaging, where examined, about four feet in depth. Several springs are constantly depositing the ore, and turning whatever vegetable matter falls in their course into iron roots, stems, leaves, &c. In one place, where the ore was mined to the depth of eight feet, a powerful spring was reached, the water of which made those that tasted it sick. The hole was consequently filled up, but a copious deposit of sulphate of iron on the rocks and in the earth about them seemed to fully explain the effects of the water. I think this spring could be made profitable by evaporating the water for copperas. The bog ore is found also at the bottom of "Lily Pond," which extends along the base of Ore Mountain.

The iron from this ore is of the best quality, and in 1856, the last year the furnace ran, the yield was 2,350 tons. The operation was then stopped, it being found unprofitable, on account, as I was told, of the want of economy on the part of the managers and agents.

August 20th was occupied by an excursion to

"The Gulf."

This is a deep gorge in the mountains, about twelve miles northwest of the Iron Works, which affords a passage for the west branch of Pleasant River. This stream rises in several small lakes still farther west, and runs through this narrow gorge with many a rush and tumble. Its valley, through which lies the path from the furnace to the Gulf, is covered with brush, maple, black ash, spruce, cedar and hemlock, the cedar and spruce being mostly in the swamps. I noticed along the path three plants, which are found in perfection only in very rich soil—spikenard, (*Aralia racemosa*, Linn.,) round leaved orchis, (*Platanthera rotundifolia*, Lindl.,) and the wood nettle, (*Laportea Canadensis*, Gaudich.) The last mentioned was of uncommon size, six to seven feet high, and formed large patches, which gave one going through them occasion to remember his journey.

The path, for some distance, is on a very interesting horseback, which extends from near the furnace, along the shore of the Mummyrungin, and through the valley in nearly a strait course, about north 30 degrees west at least four miles. It is easy to see how the two currents might come, whose meeting would form this ridge, (if horsebacks were formed thus, which my observations this summer have led me very much to doubt). One could come from the west-north-west through the Gulf, and the other from the north by a valley, which winds between the mountains in that direction, and through which a comparatively level wood road now extends for nearly thirty miles.

The Gulf, which is about five miles long, is between steep, often perpendicular and sometimes overhanging walls of dark slate, from 100 to 300 feet in height, and frequently separated from each other but a few rods. Between these cliffs the river is very swift, and its current, being frequently obstructed, abounds in eddies and waterfalls, and has worn the obstructing rocks so as to form arches and basins of various and curious shapes. The tops of the walls and the sides, where they are not naked rock, are covered with spruce and hemlock.

The position of the strata at the mouth of the Gulf is dip 85 degrees south, strike north 80 degrees east, and about three miles up the stream the dip is perpendicular and the strike north 83 degrees east. The slate is very hard, and contains numerous quartz veins, some of which are highly crystalline.

August 21st, I ascended "Saddle Rock," a mountain which is about eight miles north 36 degrees east from the Iron Works. The way thither is through a forest, much of which is of young growth, the land having been cut over to make coal for the furnace. Oak, maple and birch are the principal hard woods. On the open lands, before entering the forest, I noticed several species of aster and solidago and blueberries were abundant. The speckled alder, (*Alnus incana,*) Willd., with the hobble bush, (*Viburnum lantanoides,*) Michx., and red osier, (*Cornus stolonifera,*) Michx., covered much of the low ground. Partridges and rabbits were often crossing our path, and the guide's dog had occasion to repent laying hold of a large hedgehog, whose sharp quills gave him a prickly mouthful.

I noticed many granite boulders on the south slope of the mountain, but was disappointed when I got to the summit to find it composed of the same slate formation that I had been on so long. The dip of the strata at the summit is 63 degrees north; strike north 80 degrees east. The height of the mountain is 3,010 feet, being 2,416 feet above the ground in front of the furnace of the Iron Works. The summit is covered with blueberry bushes, the fruit of which was very abundant, but not so palatable as when produced in lower regions. The following are bearings from the summit: Mount Katahdin north 35 degrees east; west end of "B Pond" north 10 degrees east; north end of Schoodic Lake south 47½ degrees east; south end of Schoodic Lake 22½ degrees east; Ebeeme Mountain south 36 degrees east. To the north-west are several mountains, the highest of which is called "White Cap," on account of its naked white summit, which, as a hunter informed me, is composed of granite. It is about eight or ten miles from Saddle Rock, and is probably near the south-west limit of the Katahdin granite region.

The next day being very rainy, I did not leave Mr. Pollard's until near noon. When we arrived at Brownville, I found Mr. Merrill had kindly prepared some specimens of the slate, showing both their superior cleavage and fracture, and having arranged with Mr. Crocker to send some specimens, showing the dendritic markings that occur on some of the slate rock, I rode on to Foxcroft, where I spent the night. The slate formation between Brownville and Foxcroft is nearly perpendicular, and runs about north 80 degrees east. The same formation extends to Moosehead Lake, at the foot of which, in Greenville, we made preparations for the trip in the wilderness and camp life. The ride thither and these preparations occupied the whole of August 23d.

I noted the following positions of the strata at the places designated: Monson Centre, strike north 78 degrees west, dip 88 degrees south; North Monson, strike north 55 degrees east, dip 72 degrees north. Two sets of striæ were on this ledge, running north 10 degrees west, and north 20 degrees west. Shirley, strike north 75 degrees east, dip 78 degrees north. On this ledge were three sets of striæ, running north, north 10 degrees west, and north 20 degrees west. Greenville, strike north 80 degrees east, dip 85 degrees north.

We got away from Greenville about 10 A. M. on the 24th, and sailed for Mount Kineo, where we proposed to spend the Sabbath. The slate formation continued north of Greenville as far as "Ledge Island." This island is composed of a very hard, dark granite. The shore directly east of this island is composed of the same rock, which contains many quartz veins.

"Bradford's Point," on the west side and about one mile from Greenville, is composed of syenite. But at "Moose Island" we came upon mica schist having perfect joints, but very contorted strata. The general direction of the strata is north 80 degrees east, and they dip 80 degrees north. North-west of Moose Island is a small island, around which the water leaves a quantity of very fine black sand. The quantity varies at different seasons of the year, I found but very little, but my guide told me that he had "seen it when several inches thick all over the beach." The island is composed of mica schist, in which are veins of disintegrating rock that are the source of the black sand.

North of this, I saw no ledges until we came to the "Sand bar" about four miles south of Mt. Kineo, near which are numerous ledges of mica schist, the strata of which run north 85 degrees east, and dip 72 degrees north.

Aug. 26th. The wind was too strong to permit us to proceed, our canoe being heavily loaded, and therefore I spent the day about Mt. Kineo. This mountain is 770 feet in height above the level of the lake, and is composed of blue hornstone or flint. The lake is 1,071 feet above the sea, making the actual height of Kineo 1,841 feet. Its summit commands a most lovely view of the lake and the surrounding mountains. I took the following bearings from it: Squaw mountain south 10 degrees west; Greenville south 10 degrees east; Lily-bay mountains south 55 degrees east; Spencer mountain north 85 degrees east; Katahdin north 82 degrees east; "Kineo Jr.," north 60 degrees east; Two high and very distant peaks south 50 degrees west. A high mountain, probably in Canada, north 60 degrees west.

On the west shore of the lake, just opposite Kineo, is another lower hill made up of the same rock as Kineo; and I think the range extending to the east in a line with these two, of which range Kineo Jr. is the highest peak, is composed of the same compact rock. Just north of this is a siliceous grit, the strata of which run north 45 degrees east, and dip 40 degrees south-east. About two miles up Moose river, (which runs into the lake on the west side just north of the hill above mentioned, and whose course is about north-east,) I found ledges of the same grit, the strike of which is north 40 degrees east, and dip 65 degrees south-east.

On the 27th, we were able to get as far as "Farm Island," where the wind obliged us to spend the afternoon and night. This island is composed of a compact siliceous grit, strike north 42 degrees east, dip 80 degrees north; and, on the north end, strike north 42 degrees east, dip 45 degrees north. It is covered with a heavy growth of white and yellow birch, beach and maple, with hemlock, spruce and arbor vitæ. *Mentha Canadensis*, Linn, was growing in profusion on the shore.

About two miles north of "Farm Island" is "Soccatean point," on the west side of the lake. On this point is a ledge of *siliceous grit, very perfectly jointed, the strata of which run north 65 degrees east, and dip 85 degrees south. About one-quarter of a mile north is another ledge of similar rock, two strata of which contain impressions of shells in great abundance. A little farther north, I found more of the same kind of fossils, of which I secured as many specimens as I dared to put in our canoe.

North of these fossil localities the same grit extends to "West farm," a clearing of 200 acres on the west shore of the lake, and about five miles from the "north-east carry" at the head of the lake. On this clearing, ledges of slate appear again, and the formation extends to the Penobscot river. The strata at the West farm dip 55 degrees north, and run north 70 degrees east. At Centre Island, their direction is the same, with a dip 73 degrees north.

The shores on this part of the lake have a gentle slope, and are for the most part heavily wooded. The land is of good quality and capable of making fair return for cultivation. Several clearings are being made on the east side the present season, and the only wonder to me was that settlements have not been made there before. The wood around the lake does not differ much from that found at Katahdin Iron Works mentioned above. On the "West farm" I noticed for the first time the tree cranberry, *Viburnum opulus*, Linn, the berries of which are highly esteemed by some for sauce.

The lake at the north-east carry is two and one-eighth miles from the Penobscot river. The level of the lake is 1,071 feet above the sea; the highest place on the carry has an elevation of 1,147 feet, while the west branch, at the end of the carry is 1,023 feet above the sea, making the difference between the height of the lake and that of the west branch, 48 feet. I have been informed that at the north-west carry, which is a few miles above, the water of the Penobscot is the highest, so that, by canals, the lake could be run into the river, or the river turned into the lake. As it was some time after our arrival at the carry before the ox-car appeared to bear our canoe and its contents to the bank of the Penobscot, I had time to examine somewhat the flora of the place. Asters were abundant, as they are all about the lake and on the west branch, of which *A. macrophyllus*, Linn., *A. puniceus*, Linn., and *Diplopappus umbellatus*, Torr. and Gr., are the species most frequently met with. The Canada blueberry, *Vaccinium Canadense*, Kalm., and *Chiogenes hispidula*, Torr. and Gr., were also abundant; also *Linnaea borealis*, Gronov., *Kalmia glauca*, Ait., *Trillium erythrocarpum*, Michx., *Clintonia borealis*, Raf., *Ledum latifolium*, Ait., and *Uvularia grandiflora*, Smith, are found with little trouble. The shore is low, and covered for the most part with a thick growth of spruce, fir and arbor vitæ. Somewhat back from the shore, black ash, rock maple, yellow and white birch and beech occur. I saw but little pine anywhere about the lake, and the same was true all along the Penobscot, it having been mostly cut for lumber.

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*This rock is the Oriskany sandstone. C. H. H.

The old ox got our implements over safely, at last, and after boxing up the specimens I had collected about Moosehead, in order to send them back by the steamer, which goes from Greenville to the head of the lake once a week, we had time to go down the river a mile or two before camping.

The next day, we went to the head of Chesuncook lake, which is 20 miles from the north-east carry.

The land along the river is very fertile and is covered with a very heavy growth of wood, but the timber has been culled to considerable extent.

The growth consists of the same kind as that on Moosehead lake with the addition of numerous elms, which add much to the beauty of the river. I noticed also the speckled alder, the osier, hobblebush, and several species of willow. The rock is slate without interruption. The first ledge that appears is at Rag-Muff; a stream emptying about eight miles below the carry, the dip of which is 73 degrees north, strike north 35 degrees east.

The position of the strata four miles below this, at the upper end of "Great Island," is, dip 80 degrees north, strike north 25 degrees east. At the lower end of the same island, which is about a mile long, the dip is 90 degrees, and the strike north 55 degrees east. Just below "rocky rips," three miles above the head of Chesuncook lake the strata dip 90 degrees, with a strike north 80 degrees east. This ledge is distinctly marked with striæ running north 10 degrees west.

Just below it, the bank of the river is about 20 feet in height, and composed of blue clay of excellent quality.

At "Pine Stream Falls," two miles above Chesuncook, the strata run north 70 degrees east, and dip 74 degrees north.

Below these falls, the water is deep and sluggish, flowing between banks of rich loamy soil which support a heavy growth of maple, birch, cedar, spruce and fir. Where the west branch enters Chesuncook, there is a large deposit of mud, that has been carried down by the river in its freshets and left, forming, just south of the river channel, a large flat, covered with shallow water and aquatic plants.

Chesuncook Lake, upon which I spent August 30th, is 16 miles in length, and averages about 1½ miles in width. Its gently sloping shores are covered with maple, birch, cedar, spruce and fir trees, except for about 1½ miles on each side of the lake at its upper part, where the land has been cleared, and is now occupied by some six or eight families. The crops raised on these clearings are chiefly grass, oats and potatoes, all of which find a ready market among the lumbermen, who make the "Head of Chesuncook" one of their most important rendezvous. The land is easy of cultivation, and yields a very fair crop. The shores at the lower part of the lake are more sandy, and do not present so much attraction to the settler. I met with no ledges except slate until within six miles of the foot of the lake. The positions of the slate ledges on the west side of the lake I noted as follows: At the "head of the lake," strike north 80 degrees east, dip 75 degrees north; 1½ miles below, strike north 70 degrees east, dip 84 degrees south; 2 miles below the "head," strike north 70 degrees east, dip 84 degrees south; 2½ miles below the head, strike north 70 degrees east, dip 85 degrees north; 3 miles below the head, strike north 62 degrees east, dip 45 degrees north; 4 miles below the head, strike north 57 degrees east, dip 75 degrees north; 5 miles below the head, strike north 60 degrees east, dip 75 degrees north. I then crossed the lake, and found about six miles from the foot of the lake a very interesting conglomerate, the pebbles in which were in regular layers, and between these layers a quartzose cement, forming a very hard rock. Where the surface of the ledge was exposed to the water of the lake, the pebbles were dissolved out, leaving the surface of the rock full of depressions. On this ledge *Lobelia Kalmii*, Linn., was very abundant. The strata of this conglomerate run north 70 degrees east, and dip 25 degrees north. Just south of this are ledges of quartz rock and siliceous grit, and this rock extends along the shore about a mile and a half, the general direction of its strata being north 50 degrees east, and dip 25 degrees north. About two and a half miles from the foot of the lake is a ledge of greenstone, forming a high point extending into the lake, and opposite this, on the west shore of the lake, is a little island, (covered when the water is very high,) composed of the schistose conglomerate above described, the strata of which run north 30 degrees east, and dip 45 degrees north-westerly. Near the outlet of the lake is a point composed of very hard, dark granite, to the south of which slate and quartz rock occur again, with a strike north 80 degrees east and dip 85 degrees south. At the outlet is a dam with twelve gates, used by the log drivers in spring to keep the water back in order to float the logs from places where otherwise the water would not reach, and also to accumulate water during the night, so that the current may be stronger during the day. From Chesuncook to Ripogenus Lake, which is about three-fourths of a mile, there is a constant series of waterfalls, which do not permit a canoe to run. There is a good path, however, cut through the woods, by which we carried our canoe and utensils The falls are on quartz rock, which keeps the position above indicated to the head of Ripogenus.

The shores of Ripogenus are steep, and covered near the water with alder, tree cranberry and birch. Back from the shore the growth is heavy, and abounds in hemlock, cedar, spruce, black ash, white and rock maple, &c. On the south shore is a large clearing, with an uninhabited house and two barns. This is owned by timber proprietors, who used it for raising provender for their teams. The timber being mostly cut in that section now, there is no longer the same necessity for the farm, and therefore it is left to run to waste. Along the beach I found boulders containing fossils like those on the north part of Moosehead. Slate ledges, with quartz rock, crop out at intervals, their direction being north 30 degrees west, dip 45 degrees south.

At its lower extremity the lake is bordered by high hills composed of slate and quartz rock. Between these the river flows, forming numerous waterfalls, until about three miles below, it becomes again smooth enough to allow of navigation. This makes the longest portage on the west branch, and is known as the Ripogenus carry. At little below the lake is the most wild and interesting waterfall found on the Penobscot. The river is divided by an island into two parts, one of which falls over a perpendicular wall of conglomerate, like that described above as found at Chesuncook, some twenty feet in height, and then goes foaming and boiling along, crowded between the island and a high wall of slate which forms the north bank. The other flows more smoothly over an inclined plane of this same conglomerate, the surface of which is full of depressions and ridges, and meets the first at the foot of the island where they take the next fall together.

The slate on the island dips south 20 degrees west, but the conglomerate dips 45 degrees north, with a direction about east and west.

The path leaves the stream at this place and leads round over the hills to the end of the carry. About a mile below Ripogenus granite appears and marks the beginning of the Katahdin granite region. For from this place to the outlet of North Twin Lake we find no other rock in place. The land about the carry is covered with boulders, and the soil is poor. The lower end of the carry is 663 feet above the sea, while Ripogenus lake has an elevation of 878, making the fall which the water makes in the three miles, 215 feet. Below this portage the river is comparatively smooth for 2½ miles; then it widens so as to form the Ambajemackomus, a beautiful sheet of water about a mile in length and from ⅛ to ¼ of a mile in width. The shore is low and covered with birch, maple and arbor vitæ. From some of the trees the pendent lichen, *Usnea longissima*, Ach., was hanging in rich profusion. To the south is a range of mountains, the top of two of which are naked granite, while the others are wooded to the summit. The foliage just putting on the hues of autumn exhibited on these slopes a most exquisite variety and mingling of color. The various intensities of green on the maple, the yellow of the beech, with the brown of the birch and the deep shades of the evergreens, and here and there a bright spot of orange or crimson, were all beautifully blended. Below this lake is a portage, half a mile in length, at the lower end of which is a waterfall of much beauty, where the river rushes over a perpendicular ledge of granite ten feet in height, and then goes bounding along over and among massive boulders of the same rock. Along this carry we found an abundance of blueberries and whortleberries. The land is rocky and covered with young growth, and the soil presents no attraction for farmers.

For four miles below this a canoe can safely run; then another rapid obliges one to make a short portage called the "Sourdnahunk carry." Near this empties the Sourdnahunk brook, a rapid stream, which rises in several small lakes among the mountains west of Katahdin. In this brook just above its mouth are some remarkable falls, at the foot of which the guide had excellent success in trouting. This gave us an agreeable change in our living, from the pork and hard bread, of which up to this time our food had entirely consisted. It is four miles from the mouth of the Sourdnahunk to where the Aboljacknagesic and the Aboljacarmeguscook pour their clear, cold water into the west branch within a few rods of each other. These streams are both fed from Mt. Katahdin, the former from its south-west slope, while the latter flows from Katahdin pond, which is south-east of the mountain.

The land on the banks of the river is fertile, and to the south is covered with a heavy growth of wood, but on the north side of the river it has been burned over some time and is now covered with shrubs and young growth. Blue berries, bunch berries, and wild red cherries were abundant.

Just opposite the mouth of the Aboljacknagesic we pitched our camp, Sept. 2d, and remained there through the next day, which was very rainy.

On the 4th, we went to Mt. Katahdin. Taking a course direct for the great slide, which is north 37 degrees east from where we camped, we were so fortunate as to strike, as soon as we got into the woods, the path, "spotted" by Mr. Bowditch some years since, which leads across the foot of the great slide and on to the west spur, where the ascent is more gradual than at any other part of the mountain. We followed this path with some difficulty (for the spotting was not complete,) to where it ends on the west spur, and camped as far up the mountain as we could find wood large enough for fuel. The next day we ascended the mountain; had a good view from the summit, and got back to our camp on the Penobscot about dark.

For about two miles from the river, the land is open and covered with grass, berry bushes, and other shrubs. At the mouth of the "Aboljacknagesic," I found *Lobelia Dortmanna*, Linn., *Proserpin-*

sca pectinacea, Lam., and *Sagittaria simplex*, Pursh. After crossing this open land, it is well to look carefully for the path above mentioned, as, out of the path, the thick growth of young ever greens that succeeds, is very difficult to penetrate. A swamp covered with cedar, red maple, black ash and alder, has next to be crossed. Then the path leads through a heavy growth of yellow and canoe birch, pine, hemlock, mountain and white ash, beach and aspen; but as we ascended the mountain, fir gradually takes the place of these, until at an elevation of 3,000 feet little else is found. The top of the mountain is a plateau about three miles in length, which gradually rises from the top of the west spur to the summit. On this plateau we find nothing but the most hardy plants. The lower portions of it are covered with the mossy lichen, *Cladonia rangiferina*, Hoffm., among which the *Alsine Greenlandica* Finsl., and *Soladago Virga-aurea*, var. *alpina*, Bigel., were sparingly growing. At its lowest and western extremity were patches of the cowberry, *Vaccinium Vitis-idaea*, Linn., and the alpine bearberry, *Arctostaphylus alpina*, Spreng. *Lecidea geographica*, Schaer., was abundant on the rocks, all over the upper portion of the mountain.

It is not in my province to describe the landscape in view from the summit. In fact it is beyond description. To look into "the gulf" only, that yawning abyss, which seems almost bottomless, is worth crossing the ocean; and then to look to the south and west upon that broad expanse filled with forests and mountains, lakes and streams, all mingling in surpassing loveliness, fills the soul with emotion none but a poet can express. I will only say that the view is much superior in beauty and in interest to that from Mt. Washington.

The mountain is composed entirely of granite, covered on the sides with loose material, consisting of gravel and boulders, among which I noticed some of red jasper, sandstone and siliceous grit, the last containing impressions of shells.

The distance from the west branch to the base of the "great slide" is about six miles, thence to the west spur two miles, and thence to the summit five miles. The distance from the base of the slide to the summit is not over three and a half miles, and until a path is cut through to the top of the west spur, I should recommend to go up the slide by all means, except perhaps in early spring, when the frost may have rendered the slide, for the time, dangerous.

On the 6th, we continued our course down the river. We soon came to the Aboljacarmegus portage, which is about one-eighth of a mile in length. Three-quarters of a mile below this, is the "Pockwockamus carry," which is one-eighth of a mile long. At both these portages, the river falls over ledges of fine granite, which presents no signs of disintegration, and is well situated and easy for working. Below Pockwockamus, the river is smooth for two and a half miles, when it enters the Debskoneag, a beautiful little lake surrounded with low shores that are covered with a heavy growth of birch and maple. Below this lake is a short carry, and then smooth water to the Passagamook lake, a distance of three miles. At the foot of this lake is another short carry, and two miles from this we entered Ambejijis lake, by which we camped for the night.

The shores of these lakes are low and backed by hills of considerable height, covered with thick wood, made up mostly of birch, maple, cedar, and spruce. Below Ambejijis, there is a portage a quarter of a mile in length, below which the water is navigable for twelve miles, through a part of Pamedumcook, the largest lake in the region, (being, I should judge, seven miles in length by four to five in breadth,) and through N. Twin, a narrow lake some five miles long.

At the outlet of N. Twin lake, we found the river completely filled by a "jam of logs," which extended a mile and a quarter. Over this we were obliged to carry our canoe and baggage, which consumed the remainder of the 7th. At the end of this "jam" we found a deserted logger's hut, in which we had comfortable quarters for the Sabbath. This hut was near a dam similar to that at the outlet of Chesuncook. Near the outlet of N. Twin lake is the south-east limit of the granite, and the quartz rock again appears. In a ledge at the dam above spoken of, the strata run north 60 degrees east, and dip 87 degrees south.

On the 9th, we proceeded down the river through Quakis Lake, to the sled road that leads over to Millinocket stream, by taking which, we avoid the grand falls of the Penobscot. The distance from North Twin dam to this portage is three miles and the portage is two miles long. It is called "Fowler's carry," from the man who owns the road and occupies a farm near the Millinocket stream. The quartz rock extends to Quakis Lake. At the foot of this lake is a ledge of slate running north 55 degrees east, with a dip 87 degrees south, and from this point the same formation of argillaceous and siliceous slates extend without interruption to the mouth of the west branch.

Mr. Fowler's ox sled bore our canoe and baggage in safety to Millinocket stream, and after a paddle of two miles, we came into Shad pond, the last widening of the west branch.* The land in this region is poor, and scattered over with granite boulders, some of which are of great size. Along Millinocket stream, however, there are meadows of some fertility, and a few settlers have been attracted thither, who have farms near the mouth of the stream.

The shores of Shad pond are low, and the water is shallow for a considerable distance into the lake, thus affording good situation for pickerel-weed, *Pontederia cordata*, Linn., and buck-bean, *Menyanthes trifoliata*, Linn., which grow there in great profusion. On the shore were numerous asters, among which I noticed the following species:—*A. cordifolius*, Linn.; *A. simplex*, Will'd.; *A. Tradescanti*, Linn; *A. longifolius*, Lam., and *A. macrocarpus*.

The river below this pond is very swift, and flows much of the distance to Nicatou, over ledges of slate, which, when the water is low, render navigation very difficult and hazardous to any thing so frail as a birch canoe. The direction of these slates is north 60 degrees east. Just below Shad pond they dip 87 degrees south, but two miles below, the dip is 88 degrees north, and they keep nearly this position all the distance to Nicatou, which is twelve miles from the pond. I saw none that could be worked for roofing slate, all being very hard and brittle. There are farms here and there all along this distance on the banks of the river, which yield moderate returns for cultivation, but I should advise one to see Aroostook county before settling on them or any where else on the west branch.

Concerning the geology of the portions south-west from Moosehead Lake, we can add a word from Dr. Jackson's Third Report. He went up Moose river. About three miles from Moosehead Lake upon this stream, are ledges of siliceous slate, like the Oriskany slates on Moosehead. At Brassua Lake the Oriskany fossils are found, the strata dipping 50 degrees south-east. Boulders of trap are found here in great abundance. Granite is found in places on the east shore of the lake. The Oriskany slates are found also on the west shore of the lake. The Oriskany rocks also appear upon Long pond, consisting of flinty slate, quartz rock and trap. Clay slate dipping 60 degrees north-west also appears.

Between the north-west corner of Jackman and the Canada line, the rocks are calciferous slate. For the first part of the way they dip 60 degrees north-west, and then south-east at about the same angle. Bald Mountain is probably composed of granite.

Returning below Jackman, in Parlin pond, the Oriskany sandstone is well developed, containing a great many fossils. The rocks at the Forks of the Kennebec are calciferous slates.

According to Dr. Stephenson's Report, the rocks on the head waters of the Megalloway river are clay slate, extending as far south as Wilson's mills, in the townships north of Umbagog Lake. South of the mills the rock is granite.

CHEMICAL REPORT.

To C. H. Hitchcock, A. M.

Sir:—In this communication I present the results of various chemical investigations, conducted during the present season, at your request.

Mineral Waters of Maine.

Many persons have expressed a desire to see an extended account of the mineral waters of our State, and therefore this paper, though quite imperfect, has been prepared. I trust that the following prefatory remarks will not be thought out of place. Pure water is, chemically, the protoxide of hydrogen; one atom of hydrogen uniting with one atom of oxygen to form a substance differing, in all its physical properties, from either of its components. Water obtained by careful distillation is perfectly pure, since in this process its impurities are left in the boiler or retort, and the vapor alone passes over, condensing and forming water in its liquid state. Pure water is never found in wells or springs or in rivers; rain-water alone approximating to that degree of purity attained by distillation. And, in this connection, it will be remembered that rain-water is really a distilled water. Vapor, arising from our rivers or lakes, forms the clouds which yield rain. We may, for most practical purposes, consider the water falling from the clouds to be free from impurities or any foreign substance, and yet rain is, chemically, far from being pure, having absorbed more or less from the atmosphere. After rain has fallen on the earth, it percolates through the soil, and, dissolving various earthy salts, finds its way to our wells or springs. Owing to the great abundance of these salts in the vicinity of some wells, the solution is much stronger than that in other localities; and when the presence of these salts is hardly appreciable by the taste, and yet forbids the free use of soap or other detergents employed in washing, we call the water "hard." When the solution becomes so strong that the taste readily perceives it, the water is called "mineral." This use of the word has become very general, although by its acceptation we seem to entirely overlook the fact that all water is a mineral—a mineral as truly as common lime. From the earliest times, springs, from which flows water charged with earthy salts, have attracted much attention, and have attained different degrees of celebrity as remedial agents. The use of such water has produced, in many cases, considerable relief in some diseases, and cures have been thought to be attributable alone to the medicinal spring. In many instances, however, the relief experienced was due more to the change of scenery, air and occupation than to the employment of the water either as a beverage or for baths. In Maine, a few springs have been brought to the notice of the public, and have met with a share of patronage, but so far as I am aware, no account of all these waters has ever been published; in fact, until lately, some had never been analyzed. Thus it will be seen that the work of describing them is, in reality, a new one, and therefore deserves more time than I have been able to devote to it.

Mineral waters may be conveniently classed into Cold and Thermal Springs. We have no thermal or "warm" springs in our State;—the popular name of "Boiling Springs" having been given to such as have a small current of air passing through them, causing a peculiar bubbling resembling ebullition. The mineral springs of Maine are all "cold," and, though they vary slightly in temperature, never become so warm as to be considered thermal. In order to present a convenient classification, the mineral waters of Maine will be arranged, according to the prevailing ingredient, into these classes:

1. *Sulphureous.* 2. *Chalybeate.* 3. *Saline.*

1. SULPHUREOUS SPRINGS.

These are at once recognized by the peculiar odor of one of their constituents, sulphydric acid, or, as it is sometimes called, sulphuretted hydrogen. The odor is that attending the decomposition of certain organic substances—*eggs*, for instance. The water commonly holds in solution certain salts of iron and alumina, but the medicinal efficacy depends entirely upon the sulphydric acid. The use of such waters is *indicated* where a direct influence upon the cutaneous system is desired. In many chronic skin diseases, the water used externally and internally often produces marked effects; and good results have been noticed by Dr. Armstrong in the treatment of chronic rheumatism and gout.* This is not the place to notice, at length, the medicinal properties of mineral springs, but it has been thought best to allude to those affections in which their use is indicated.

The celebrated "Togus Springs" near Augusta may be assigned to this class. I sincerely regret that no facts concerning this water have been placed in my hands, but I hope that a full analysis will soon be made, or, at least, that previous analyses may be published.† This, at least, is known—that Mr. Beals has, by his enterprise, rendered Togus a most favorite resort for invalids and summer visitors.

Bethel Spring.

This came to my notice during the present season while examining the plants of this highly interesting locality, It is situated near the hill called "Sparrowhawk," and derives its sulphuretted hydrogen from a bed of decomposing pyrites in the vicinity. The odor is quite marked and noticeable at some distance from the spring. The temperature of the water on the 13th of June was 42 degrees Fahrenheit. Its taste indicates the presence of sulphate of iron. It was impossible for me to transport a sufficient quantity of this water for a prolonged and careful examination. From the small amount I procured at the spring, and retained in a sealed bottle until this autumn, it was ascertained that there was present nearly nine cubic inches of sulphuretted hydrogen in one hundred inches of water. The percentage of sulphate of iron was very small, but gave to the water a distinctly astringent taste.

New Limerick Spring.

I have lately received information concerning a sulphureous spring found in New Limerick, Aroostook County. No specimen of the water has yet been received by me, but I have no hesitation in considering it to be a strong solution of sulphuretted hydrogen.

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* Dr. J. Armstrong, as quoted by Pereira. Mat. Med., Vol. 1, pp. 808–9.

† It is my impression that the lamented Professor Cleaveland analyzed the water of this spring.

West Newfield Spring.

This spring occurs in a meadow nearly two miles from the village, and is indeed a remarkable water. Not only is the water very thoroughly impregnated with the odor of sulphuretted hydrogen, but the sulphur deposit noticed so often in laboratories was noticed at this spring. When water holds sulphuretted hydrogen in solution, there is often thrown down from it upon exposure to the air, a yellowish white powder, which is at once recognized to be sulphur. And so, around the sides of this spring, sulphur had been deposited. Temperature of the water, 44 degrees Fahrenheit.

Having nothing in which to carry away a sufficient quantity of the water, I am unable to give positively its composition. The percentage of iron held as a sulphate is exceedingly small, and the taste of the water is consequently less unpleasant than that of many astringent chalybeate springs. It is sufficient to say that it is one of the best sulphur-waters yet noticed in the State by any of the gentlemen attached to the Survey. If it were not in such an uninviting place (a marshy meadow at some distance from any village), it would become a celebrated spring. As it is, it has considerable local reputation.

Sulphureous springs have been noticed at Saccarappa, at Wells, and near the Katahdin Iron Works.

2. CHALYBEATE SPRINGS.

Various mineral waters hold in solution carbonate and sulphate of iron. These are formed by the decomposition of iron pyrites, which is composed of two atoms of sulphur and one atom of iron. Occasionally we find in mineral waters the carbonate of the protoxide of iron. Upon exposure to the air, a portion of the carbonic acid escapes, and the iron is deposited as a protoxide, which speedily becomes a sesqui-oxide upon union with more oxygen from the atmosphere. The same deposition of sesqui-oxide takes place when the waters are boiled, and by this simple test they can be distinguished from those containing sulphate or chloride of iron. Springs, the water of which contains any of the salts of iron, are called *chalybeate*, and may be usually known by a very distinct astringency. Around the sides of such springs, and upon twigs and leaves in the water, we find a deposit of peroxide of iron, which is often so abundant as to tinge the water flowing from it. The dark color so often noticed in such springs arises from the presence of gallic acid in the bark of wood falling into the water; the gallic acid and oxide of iron forming a dilute ink.

Pereira, in his great work on Materia Medica, states that chalybeate waters are indicated in cases of debility, but their use is contra-indicated in febrile or inflammatory conditions of the system. Numerous springs of this character have been discovered in the State, and may be conveniently arranged into two classes, according to the acid which predominates in the water. This division into two classes, Carbonated Chalybeates and Sulphated Chalybeates, is, after all, quite arbitrary, because in many cases a sulphated water contains carbonic acid, while a carbonated water may hold in solution a sulphate of iron.

Carbonated Chalybeates.

These are frequently met with in many parts of the State, and in nearly every instance I have also found sulphate of iron as well as carbonate of iron in solution.

West Bethel Spring.

This is situated near the West Bethel Station at the base of a granite mountain called Anasagunticook. It has already become a place of considerable resort for invalids and summer visitors. The spring is not far from a ledge of pyritiferous mica schist, from the decomposition of which it procures its constituents. But a very small quantity of this water was examined by me, and with the following results: Temperature, June 18th, 42 degrees Fahr.

In 6,000 grs. there were found 5.92 grs. of dry salts. Free carbonic acid could not be determined after the lapse of time between June and October, as the bottle of water was not carefully sealed at the time it was procured.

Carbonate of Iron, - - - -	2.24
Sulphate of Iron, - - - -	2.23
Sulphate of Alumina, - - -	.82
Magnesia, - - - - -	.10
Traces of Lime, - - - -	.04
	5.13 grs.

The spring-water is dark colored from the trace of gallate of iron present in it. In taste, it is not unpleasantly astringent. The alumina in this water is not in sufficient quantity to render it objectionable in diseases of the heart.

Fryeburg Spring.

This spring is on the farm of Mr. Hutchins in the western part of the town. When seen by Dr. Holmes and myself in July, it was covered with a thick film of peroxide of iron, and possessed a faintly astringent taste.

Temperature of the water, July 3d, 1861, 43 degrees Fahr.

Analysis gave these results:

Carbonate of Iron, - -	2.10
Sulphate of Iron, - -	1.21
Traces of Magnesia and Lime,	.10
	3.41 grs. in 6,000 grs.

The film of per-oxide of iron extends down for several rods from the source of the water, indicating that the amount of iron is by no means inconsiderable. So far as I am aware, no medical use has been made of this water.

Upper St. John.

While walking along the west bank of this river near its junction with Great Black River, my attention was attracted to a spring from which flowed water rendering the ground below thoroughly impregnated with per-oxide of iron. The water we found to be quite as strong as any noticed in other parts of the State, but its present inaccessibility forbids us from more than alluding to it as a carbonated chalybeate spring.

Ebeme Spring.

Water from this spring was handed to me by Mr. Houghton of the Survey. It comes from a locality well known to be ferruginous and it has attained a more than local reputation as a medicinal agent.

Analysis of 6,000 grs.

Carbonate of Iron, - - - -	5.62
Sulphate of Iron, - - - -	1.23
Sulphate of Lime and Alumina, - -	2.01
Traces of Magnesia, - - -	.11
	8.97 grs.

The free carbonic acid in this water can not be far from four cubic inches in 100 cubic inches of water.

From this analysis, it appears that this water is a superior chalybeate, having free carbonic acid, giving it a pleasant taste.

Sulphated Chalybeates.

Several springs of this character have been noticed in various parts of the State, but they generally contain carbonic acid in solution. I am inclined to consider the sulphated chalybeate springs containing more or less carbonic acid as more common than any others in the State.

North Waterford Spring.

Mr. Farnum Jewett of the village of North Waterford very kindly accompanied Dr. Holmes and myself to this spring. This water has not only a decided astringent taste, but it produces a singularly nauseating effect even in small draughts. The spring is on the bank of a body of water of some size, a mile or two northwest of the village, and is in a locality unfavorable in every respect for rendering it a place of any resort. A pint of water was conveyed away from this spring in a bottle which I was unable to seal for several days, so that my results of analysis must be considered as somewhat modified by loss of carbonic acid.

Sulphate of Iron, - -	4.01
Sulphate of Alumina, -	2.73
Sulphate of Soda, - - -	.42
Traces of Magnesia and Lime,	.09
	7.25 grs. in 8,000 grs.

Temperature of the water, July 15th, 3 o'clock P. M., 40 degrees Fahr.

A little oxide of iron was detected around the edges of the spring and covering twigs and leaves which had fallen into the water.

This spring has considerable local reputation, in cases of dyspepsia and anæmia.

Bethel Spring.

This is near the village of Bethel Hill. It was shown to me by its discoverer, Capt. Nathl. Chapman. It is a simple solution of sulphate of iron and sulphate of alumina. From its proximity to the village, it is likely to attract the attention of those summer visitors who frequent this charming town. The water was examined after a heavy rain, and on this account, no estimate of the amount of the earthy salts could be made with certainty. It can be with safety considered a fine, palatable, chalybeate water. The proportion of alumina is quite small, and does not interfere with the direct tonic effect of the iron.

There are very many other sulphated chalybeates which ought to be mentioned, but through lack of time and space I can make only a brief allusion to their localities, which are as follows: Gorham, Dixmont, Andover, Newry, Biddeford, one of the islands in Portland harbor, Harpswell, Topsham, etc., etc. As far as my observation extends, each of these springs contain both sulphate of iron and a carbonate of the oxide of the same metal.

3. Saline Springs.

This class is smaller than the other two, but certainly as important as either.

Lubec Spring.

One of the most interesting of these occurs at Lubec, near the head of South Bay. Not having been able to examine this water myself, I avail myself of the analysis made in 1836 by Dr. C. T. Jackson of Boston:

1,000 grs. of the water yield 3.5 grs.; or in a standard pint of the water, 30.63 grs.

100 grs. of this salt (dry,) gave, by analysis—

Chloride of Sodium, -	64.0
Sulphate of Lime, -	3.6
Chloride of Magnesium,	20.2
Sulphate of Soda, -	9.0
Carbonate of Lime, -	2.0
Carbonate of Iron, -	.8
Chloride of Calcium, a trace,	
Carbonic acid,	
	99.6 leaving (as loss in analysis,) .4 gr.

I do not know that any application has been made of this water as a remedial agent for either external or internal use.

Scarboro' Spring.

This is situated near a slight elevation on the east of the broad marsh, two miles from the coast line, but within reach of tide-water.

From its possessing a taste more distinctly saline than sea-water, I was led to analyze it with the following results:

10,000 grs. of the water gave 31.91 grs. of salt, which were analyzed after desiccation.

Chloride of Sodium, - - -	26.052
Chloride of Potassium, - - -	.521
Chloride of Magnesium, - - -	2.121
Sulphate of Magnesia, - - -	2.012
Sulphate of Lime, - - -	1.020
Bromide of Magnesium, a trace,	
Carbonate of Lime, a trace,	
	31.728
Loss, - - - - .	.182
	31.91 grs.

Machiasport Spring.

Mr. Hitchcock visited, at the request of Capt. Moore, a saline spring in the west part of Machiasport. The only notes he recorded are concerning its location near the salt water line, and a conjecture that it is a magnesian spring. I am sorry that a portion of this water could not have been sent to the State Laboratory for analysis, as it was thought by Mr. Hitchcock to be an unusually interesting spring.

Mount Zircon Spring.

This water does not properly come in this class of saline springs, but it has been thought best to describe it in this connection. The spring is one of remarkable clearness and purity. Through the water, there rise bubbles of common air which give to the spring the popular name of "boiling." The spring is situated in Milton Plantation, Oxford Co. I have before me the results of an analysis of this water, conducted by that eminent chemist Dr. A. A. Hayes of Boston. We may receive his authority without question; for in addition to great experience, he brings to his work a scrupulous carefulness which renders the results of his investigations worthy of undoubted credence.

Mr. D. D. W. Abbott, the enterprising proprietor of the spring, and the landlord of the comfortable Hotel within a few rods of the water, will excuse me for transcribing, in full, the results of Dr. Hayes analysis.

"This water is colorless and transparent; it sparkles when agitated, and does not deposit any matter when it is boiled. Its action is alkaline, and the *dry* salts found in one standard gallon weigh only 2.043 grs., but in a moist state 4.215 grs. This water belongs to a class of waters almost pure, which act on the human system in consequence of the slight alkaline constituent, and the change of habit induced. It resembles the Ben Rhydding Water, Yorkshire, England.

In a standard gallon the following salts are present, considered as dry:

Silicate of Potash, - - -	1.110 grains.
Sulphate of Soda, - - -	0.490 "
Chloride of Sodium, - -	0.100 "
Crenate of Iron, - - -	0.310 "
	2.01 "

When crystalized, these weigh 4.215 grs. None of the more active bodies could be found dissolved, and the gaseous matter is Atmospheric Air in part and Nitrogen in part: no Carbonic Acid. Waters of this class do always affect the functions of the kidneys, in cases where the use of other water or food has induced derangement, and they have the character of 'lightness,' which allows large volumes to be drank freely. The characteristic ingredient is the Silicate of Potash."

One is at once struck with the great purity of this water. We read in Vol. I, of the Mat. Medica of Pereira, who quotes Sir Chas. Scudamore, that the Malvern Springs in England have the reputation of being remarkably pure, containing only one-third of the solid matter found by Mr. Phillips in the Thames' Water at Chelsea. Mr. Phillips has recorded that he found 19.40 grs. of solid matter in a standard gallon of the water of that river; of course a third of this would give us over 6 grs.

The Mt. Zircon water contains only 4 1-5 grs. in the gallon.

Poland Springs.

A spring in Poland, much resembling the last in character, has lately attracted considerable attention from several cases of relief in diseases of the kidneys. It is stated by many of our best authorities in such diseases that pure water, or even water nearly pure, has a very beneficial effect in lithiasis and kindred derangements. Such water that of the Poland Springs appears to be. It comes from a granitic soil, running over a singular variety of granite, and is presented to us strikingly pure.

An examination of this water failed to detect any substances differing from those found by chemists previously analyzing it. A standard gallon gives less than 3.12 grs. of salts containing water of crystalization.

The salts are principally Silicates of Potash and Soda, resembling very remarkably those found in the water from Mt. Zircon. It can be safely recommended in all cases where a pure water is required.

In concluding this hasty and very imperfect sketch, let me add a word in relation to the analysis of mineral waters. It is very doubtful whether the substances we detect by reagents in the laboratory, exist in the same form in nature. Many of these basic substances are in chemical union with the same acid, and the work of estimating the amount of each salt must be done by computation from tables of chemical equivalents. I may be allowed to illustrate this by an example, at the risk of stating a fact well known to many who read this article:

In a certain mineral water, after preliminary analysis, we detect a definite amount of Sulphuric Acid. Soon we discover fixed quantities of Soda and Magnesia. If we do not detect any other bases we take from a standard table of chemical equivalents the "combining numbers" of Sulph. acid, of Soda and of Magnesia. This found, we can easily compute the amount of Sulphate of Soda and of Sulphate of Magnesia. It will be at once seen that different results can be attained by different chemists in analyzing the same water, as each may have his own views in relation to the real combinations of the acids and the bases detected by them. During the present year, I have seen two analyses of a certain water in Maine, in which one chemist finds Silicate of Potash and Sulphate of Soda; another detected Sulphate of Potash, Sulphate of Soda, and free Silicic acid! It is not too much to say that, even with all the works yet published on this subject, not overlooking the remarkable prize essay "Hydrotimetrie," the whole matter of waters containing mineral substances in solution, is still involved in much obscurity, and the action of such waters upon the system is still more obscure.

Sea Water.

The high tides at the eastern part of Maine afford excellent facilities for manufacturing salt, should the demand for this article and a diminished supply enhance its price. The salt obtained by direct evaporation of sea water contains various substances not found in commercial rock salt. A list of these substances and the proportion of them noticed in sea water is here given. The analyses are by Schweitzer and Laurens.

	Constituents (as found by Schweitzer in the English Channel).	(as found by Laurens in the Mediterranean).
Water,	964.74372	959.26 grs.
Chloride of Sodium,	27.05948	27.22
Chloride of Potassium,	0.76552	0.01
Chloride of Magnesium,	3.66658	6.14
Bromide of Magnesium,	0.02929	——
Sulphate of Magnesia,	2.29578	7.02
Sulphate of Lime,	1.40662	0.15
Carbonate of Lime,	0.03301	0.20
	1000.	1000.

Balard found also iodine in the Mediterranean.*

Thus we see that there is in sea-water an amount of pure salt not exceeding three per cent. The foreign substances altogether amount to one-half of one per cent.

Marls.

Two specimens of marls have been handed me; one from Fremont, Aroostook County, the other from Canterbury, New Brunswick. The marl from Aroostook County occurs in extensive beds, which have been described by Mr. Hitchcock in his report. It is a white powder cohering into small lumps of a brittle character. Analysis of the marl gave the following results:

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* Pereira Mat. Med., vol. 1, p. 802. English edition.

Carbonate of Lime,	84.51
Carbonate of Magnesia,	.24
Oxide of Iron, Fe_2O_3,	2.12
Organic matter of vegetable origin,	2.08
Clay and Silica,	9.13
Loss by analysis,	1.92
	100.

The marl collected at Canterbury, in the province of New Brunswick, is of a darker color, and contains more shells. In its other physical properties it does not differ from the Aroostook marl. Analysis of this gave the following results:

Carbonate of Lime,	82.12
Carbonate of Magnesia,	.05
Oxide of Iron,	1.52
Vegetable organic matter,	2.72
Phosphate of Lime,	.54
Alumina,	8.61
Silica,	3.42
Loss by waste,	1.02
	100.

The amount of phosphate of lime in this marl, though very small, is yet sufficient (about eleven pounds to the ton) to enhance its value somewhat beyond that of a simple calcareous manure.

The whitish substance covering the bottom of Burnt Meadow pond in Brownfield, is composed of the remains of fossil infusoriæ. It is found to be nearly pure Silica with a little Carbonate of Lime, and Alumina.

Manufacture of Sulphur.

It has been thought advisable to remind the people of this State that from the vast beds of iron pyrites occurring in various parts of Maine, we can easily obtain commercial sulphur, should the home demand for it exceed the foreign supply. Iron pyrites is a bisulphuret of iron, two atoms of sulphur uniting with one atom of iron. If heat be applied to the above compound, we obtain one atom of sulphur free from the iron. This fact renders it easy for us to obtain sulphur in large quantities.

The simple process given by Gmelin will be very briefly described. Pyrites is placed in a roughly-constructed oven which communicates with long tubes. Heat is now applied, and one atom of sulphur is sublimed, forming an incrustation in these tubes. The same roasting oven will serve for an unlimited number of operations. American ingenuity will perhaps contrive a simpler and more effective apparatus than even this. Therefore let us remember that in Maine we can obtain in times of necessity a plentiful supply of this important ingredient of gunpowder.

I feel constrained to add that the field work of the Survey closed in October, leaving me very little time to accomplish the labor of analyzing the specimens collected during the summer; and this must be my excuse for any errors which may have escaped notice. As it is, various specimens still remain for examination.

Yours, with high respect,

GEORGE L. GOODALE.

LABORATORY OF THE SURVEY,
Portland, Dec. 31, 1861.

CONCLUSION.

Our reports have now all been presented. During their preparation, we have received many favors from different individuals, to whom we would here render our cordial thanks. We are under special obligations to the Portland Society of Natural History for the free use of their rooms, and the many courtesies extended us by its officers; to Dr. W. Wood, the President; H. Willis, Esq., the Vice-President, and C. B. Fuller, Esq., the Cabinet Keeper. From the members of the Canadian Survey, particularly from E. Billings, Esq., Paleontologist; from Dr. Dawson of Montreal, and T. E. Blackwell, Esq., Acting Manager of the Grand Trunk Railway, we have received many favors.

In addition to those gentlemen which we named in the commencement of our reports as having rendered us good services during the prosecution of the Survey, we would also present our thanks to Dr. Josiah Prescott and F. B. Knowlton of Farmington, Dr. N. T. True and A. L. Burbank of Bethel, Farnum Jewett of Waterford, Dr. I. B. Bradley, Hon. E. L. Osgood, and George B. Barrows, Esq., of Fryeburg, Isaac Spring, Esq., & Son, Brownfield; John Moulton, Esq., Porter; John Rogers of Kittery; Gen. S. P. Strickland, Wheeler & Lynde, and E. S. Coe, Bangor; J. T. Hardy of Brewer, and Hon. William C. Hammatt of Howland.

We have used in this report the names of rivers, lakes, mountains, &c., which are adopted in Chace's excellent map of the State. Our travels over the State have given us considerable knowledge of its geography, and we are confident that it excels even the county maps for accuracy. Our only regret is, that we could not have used it in our field work.

We have prepared a geological map of Northern Maine upon the basis of Mr. Coolidge's township map of the State. Mr. Coolidge allowed us to transfer the topography of his map to another stone, to which we added the geological markings.

The geological map of Maine, to which we referred upon page 155, is now upon exhibition, with specimens of rocks of the State, which were collected during the past summer, at the State House.

Mr. Chace kindly furnished us with an uncolored copy of his map, to which we added the colors to distinguish the rocks as well as we could. Its deficiencies in representing the geological formations of the State, are numerous, as we colored only those portions of which we had some knowledge. It may be of some service in showing to all observers, that the geology of the State has not been thoroughly explored. If permitted, as we trust, to continue the Survey, we propose to publish, at the proper time, a number of copies of a geological map of this size. They would be valuable for the use of the government and various educational institutions.

Should the work go on in all its departments, we expect to present such descriptions of the objects of Natural History in its several divisions of Geology, Mineralogy, Botany and Zoology, as would enable any persons in the State to understand them readily. We should endeavor to present such an account of our animals that any one, by answering a series of questions; in other words, by consulting analytical tables given, would be quickly enabled to find the genus, species, distribution, and habits of that animal at its proper place in the Fauna. This system would enable students to analyze animals as readily as they can now analyze plants. Such a manual of Zoology is not now in existence.

We respectfully invite all persons who feel any interest in the development of the Natural History and especially of the geological and mineralogical resources of the State, to aid the Survey by sending such facts as they may know—the results of such observations as they have made, or may make, and such specimens as they may be able to collect and feel willing to spare. Such contributions from the people always add to the sum of knowledge and sometimes lead to valuable discoveries.

Respectfully submitted.

E. HOLMES,
CHARLES H. HITCHCOCK.

APPENDIX.

COMPILED FROM RETURNS OF AGRICULTURAL SOCIETIES FOR THE YEAR ENDING DECEMBER, 1861.

SOCIETIES.	Amount received from the State.	Amount raised by the Society.	Whole amount of receipts for the year.	Amount of premiums offered.	Amount awarded.	Current expenses of the year.	Whole amount of disbursements.	Liabilities.
Androscoggin County,	300 00	720 00	1,020 00	523 00	420 00	300 00	720 00	6,000 00
Cumberland County,	200 00	363 00	563 00	775 00	607 00	380 00	-	-
East Oxford,	-	127 00	127 00	103 00	100 00	34 00	134 00	-
East Somerset,	150 00	198 00	348 00	196 00	143 00	68 00	348 00	712 00
East Washington,	150 00	490 00	640 00	450 00	342 00	158 00	-	-
Franklin County,	200 00	224 00	424 00	450 00	285 00	175 00	460 00	600 00
Hancock County,	300 00	500 00	800 00	536 00	422 00	155 00	577 00	1,200 00
Kennebec County,	150 00	226 00	376 00	341 00	233 00	188 00	376 00	175 00
Lincoln County,	300 00	408 00	708 00	355 00	265 00	460 00	725 00	100 00
North Aroostook,	200 00	250 00	450 00	286 00	160 00	26 00	-	-
North Franklin,	200 00	268 00	468 00	390 00	280 00	76 00	486 00	100 00
North Penobscot,	129 37	49 90	179 27	279 00	130 00	40 00	175 00	-
North Somerset,	150 00	150 00	300 00	231 00	194 00	-	-	-
North Kennebec,	150 00	405 00	555 00	536 00	310 00	100 00	694 00	950 00
North Waldo,	-	100 00	100 00	191 00	151 00	25 00	-	-
Oxford County,	200 00	461 00	661 00	337 00	320 00	316 00	687 00	734 00
Penobscot and Aroostook Union,	-	30 00	30 00	160 00	121 00	25 00	-	-
Piscataquis County,	99 75	97 54	197 29	236 00	166 00	44 00	-	-
Sagadahoc County,	-	836 00	836 00	628 00	445 00	254 00	672 00	2,531 00
Somerset Central,	-	337 00	337 00	450 00	285 00	50 00	485 00	1,000 00
Waldo County,	300 00	314 00	614 00	566 00	466 00	260 00	572 00	400 00
Washington,	150 00	187 00	337 00	200 00	122 00	322 00	444 00	-
West Oxford,	200 00	350 00	550 00	310 00	217 00	200 00	417 00	750 00
West Penobscot,	150 00	217 00	367 00	434 00	277 00	75 00	352 00	-
West Somerset,	-	169 00	169 00	177 00	153 00	58 00	212 00	400 00
West Washington,	150 00	244 00	394 00	292 00	236 00	115 00	303 00	-
York County,	300 00	492 00	792 00	600 00	456 00	216 00	684 00	1,300 00
Bangor Horticultural,	150 00	197 00	247 00	185 00	188 00	173 00	361 00	-
Portland Horticultural,	200 00	308 00	508 00	363 00	235 00	324 00	559 00	-

COMPILED FROM RETURNS OF AGRICULTURAL SOCIETIES FOR THE YEAR ENDING DECEMBER, 1861.

SOCIETIES.	Amount awarded for bulls.	Awarded for working oxen.	Awarded for cows.	Awarded for heifers and calves.	Awarded for fat cattle and horses.	Awarded for sheep and swine.	Awarded for all other stock.	Total offered for live stock.	Total awarded for live stock.
Androscoggin County,	16 00	27 00	21 00	10 50	63 00	12 50	69 50	281 00	221 00
Cumberland County,	24 00	48 00	25 00	20 00	74 00	37 00	24 00	326 00	251 00
East Oxford,	3 00	6 00	3 50	4 00	21 00	6 50	19 50	59 50	59 50
East Somerset,	6 00	6 50	4 25	9 25	49 00	9 25	10 00	115 00	95 00
East Washington,	19 00	23 00	15 00	14 00	158 00	33 00	–	200 00	262 00
Franklin County,	11 00	66 00	11 00	11 00	80 00	14 00	10 00	297 00	204 00
Hancock County,	3 00	10 00	5 00	21 00	17 00	18 00	45 00	242 00	119 00
Kennebec County,	20 00	67 00	12 00	7 00	25 00	23 00	–	241 00	155 00
Lincoln County,	17 00	20 00	5 00	4 00	36 00	18 00	28 00	195 00	133 00
North Aroostook,	12 00	25 00	20 00	6 00	31 00	10 00	9 00	149 00	113 00
North Franklin,	11 00	36 00	3 00	8 00	32 00	20 00	41 00	170 00	143 00
North Penobscot,	12 00	14 00	3 00	3 00	17 00	6 50	29 00	102 00	81 00
North Somerset,	11 00	6 00	4 00	12 00	21 00	13 50	76 00	159 00	144 00
North Kennebec,	15 00	35 00	13 00	9 00	101 00	41 00	25 00	318 00	239 00
North Waldo,	9 00	32 00	3 00	4 00	47 00	12 00	–	150 00	106 00
Oxford County,	29 00	29 00	3 00	7 50	76 00	20 00	37 50	209 00	202 00
Penobscot and Aroostook Union,	6 75	3 50	3 00	6 75	13 50	12 00	37 00	82 00	70 00
Piscataquis County,	13 00	24 00	5 00	2 00	25 00	23 00	–	124 00	92 00
Sagadahoc County,	28 00	19 00	18 00	23 00	70 00	24 00	60 00	328 00	241 00
Somerset Central,	10 00	24 00	9 00	10 00	38 00	47 00	–	250 00	146 00
Waldo County,	14 00	31 00	6 00	15 00	51 00	20 50	60 00	253 00	208 00
Washington County,	5 50	1 00	–	3 25	12 25	6 00	4 00	70 00	32 00
West Oxford,	9 00	12 00	3 00	4 00	25 00	12 50	22 00	152 00	88 00
West Penobscot,	23 50	11 00	7 75	21 50	41 25	22 50	36 00	256 00	163 00
West Somerset,	7 00	42 00	13 00	6 00	25 00	12 00	31 00	160 00	136 00
West Washington,	12 00	9 00	5 00	11 00	17 00	22 00	55 00	159 00	131 00
York County,	18 00	18 00	15 00	5 00	105 00	33 00	9 00	230 00	203 00

COMPILED FROM RETURNS OF AGRICULTURAL SOCIETIES FOR THE YEAR ENDING DECEMBER, 1861.

SOCIETIES.	Am't awarded for Indian corn.	Awarded for other grain crops.	Awarded for potatoes.	For other root crops.	Total offered for grain and root crops.	For fruits and flowers.	For honey and sugar.	For butter and cheese.	For agricultural implements.	For other objects.
Androscoggin,	7 50	7 00	7 50	13 75	68 00	14 25	4 00	15 00	8 00	72 50
Cumberland,	9 00	15 00	5 00	-	67 00	9 00	8 00	7 00	13 00	*288 00
East Oxford,	-	3 00	1 50	-	6 50	1 50	-	4 00	-	28 00
East Somerset,	5 25	7 00	3 75	3 25	40 00	-	-	10 00	-	20 00
East Washington,	3 50	5 75	1 50	4 75	6 00	10 00	2 00	3 50	1 50	42 00
Franklin County,	-	-	1 00	4 60	25 00	3 50	1 00	7 50	3 50	62 00
Hancock County,	9 00	7 00	2 00	14 00	82 00	10 50	3 00	5 67	20 50	130 00
Kennebec County,	-	-	-	-	17 00	8 50	-	24 00	8 00	38 00
Lincoln County,	12 50	16 00	3 50	11 50	50 00	25 00	50	16 00	2 00	46 00
North Aroostook,	-	-	-	-	-	-	-	7 75	-	33 00
North Franklin,	11 50	15 25	8 50	6 50	86 00	4 70	3 75	-	8 00	41 00
North Penobscot,	-	-	-	-	-	-	-	9 50	3 00	-
North Somerset,	4 50	10 00	4 50	50	28 00	1 50	-	-	-	-
North Kennebec,	3 00	7 00	-	-	53 00	-	2 00	12 00	4 00	10 50
North Waldo,	1 50	2 50	1 50	50	8 00	1 50	75	7 50	-	8 50
Oxford County,	4 00	8 00	3 00	-	23 00	15 00	1 00	9 25	7 00	63 00
Penobscot and Aroostook Union,	2 00	-	2 00	1 25	23 00	4 00	-	6 50	-	30 00
Piscataquis County,	4 00	10 00	3 00	-	33 00	-	1 50	18 00	3 00	-
Sagadahoc County,	13 00	17 00	6 00	13 50	76 00	14 00	3 00	25 00	-	82 00
Somerset Central,	4 00	-	4 00	-	100 00	7 00	1 50	16 00	5 00	33 00
Waldo County,	6 00	15 00	8 50	11 50	50 00	9 75	-	12 00	-	160 00
Washington County,	-	4 00	3 00	2 00	51 00	12 75	1 00	4 40	1 00	55 00
West Oxford,	-	8 50	1 50	8 00	21 00	3 00	1 00	9 50	-	-
West Penobscot,	12 00	19 00	9 00	5 50	85 00	19 00	1 00	17 25	5 00	26 00
West Somerset,	-	-	-	-	-	-	-	-	-	-
West Washington,	2 25	3 50	50	1 00	23 00	6 00	-	7 50	-	84 00
York County,	16 00	10 00	6 00	2 00	93 00	15 00	5 00	19 00	3 00	182 00
Bangor Horticultural,	-	-	-	-	-	128 00	-	-	-	60 00

* Of this sum, $220.00 were paid out for premiums on improvement of farms.

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ERRATA.

Page 57, for Fucus vesiculosus read Fucus nodosus ; and for Fucus nodosus read Fucus vesiculosus.

Page 103, lines 2 and 3 from the bottom, for one and a half mile, (7,920 feet) read more than a mile high, (6,288 feet, Guyot.)

Pages 114, line 25, 115, 116, 117 and 118, line one, for INCESSORES read INSESSORES.

Page 118, line 26, for Centurus flaviventris, *Swainson*, read Sphyrapicus vasius, *Linn*.

Page 257, line 14 from bottom, for Port read Post.

Page 246, line 10 from the bottom, for Greenish sandstones read Argillaceous limestones.

Page 374, line 6, for *nortus* read *notatus;* line 23, for *Credicia* read *Pedicia*.

Page 375, line 18, for *Odynenes* read *Odynerus*.

Page 376, last line, for and a fine *Cidarea* read *Scotosia affirmaria*.

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